# Compressed Air Magazine

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*MAKING COAL MINES SAFE PLACES IN WHICH TO WORK—SPRAYING ON LIQUID CEMENT WITH COMPRESSED AIR TO PREVENT EXPLOSIONS BY KEEPING OUT GAS SEEPAGE.*



[SEE PAGE 5 FOR INDEX TO ADVERTISEMENTS AND CONTENTS]

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VOL. XXVI, NO. II

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# Compressed Air in Modern Warfare

## How Italy and Austria were at Thrilling Grips in the Alps in the Great World War Struggle, Depending upon Compressors and Rock Drills—Pneumatic Machinery More Important than Guns

By FRANCIS JUDSON TIETSORT



AT THE height of a memorable campaign waged between the armies of Italy and Austria in the late war, a general of the Austrian High Command, conducting operations on the lofty fighting front in the Alps, dispatched to Vienna an urgent telegram of historic interest to the compressed air machinery industry. When in Vienna last September I was able to procure a copy of this message from the archives of the War Department. The telegram, of which the following is an English translation, read:

SEND MORE PNEUMATIC ROCK DRILLS AND COMPRESSORS. MORE IMPORTANT THAN ARTILLERY.

This telegram, sent in the stress of a crucial military campaign, really epitomized the necessities of the situation. High in the Alps, sometimes at altitudes of from 7,500 to 10,000 feet, were two great armies, each of many component divisions, facing each other in a life and death struggle for mastery. The fate of Southern Europe hung in the balance on the results of the efforts of these armies.

Shelter for the opposing troops, numbering a total of 2,000,000, communication with the rear, supplies, ammunition—everything that permitted the maintenance of positions on these Alpine heights, depended upon the abilities of the engineer corps to burrow into the sides of the forbidding mountain dolomite. And it was here that took place the greatest rock-drilling contest ever known in the world's history.

Roads, tunnels, billets and gun emplacements were drilled and blasted out by both the Italians and the Austrians with the most desperate and feverish energy. Hammer drills driven by portable air compressors, hauled with great effort up the heights, clacked and puttered night and day ceaselessly through arduous days, months and years. Steels were sharpened, and drills and compressors were repaired and overhauled in temporary shops that had been established in previously inaccessible spots, where only the feet of the wild goat or of some intrepid mountain climber had previously trod.

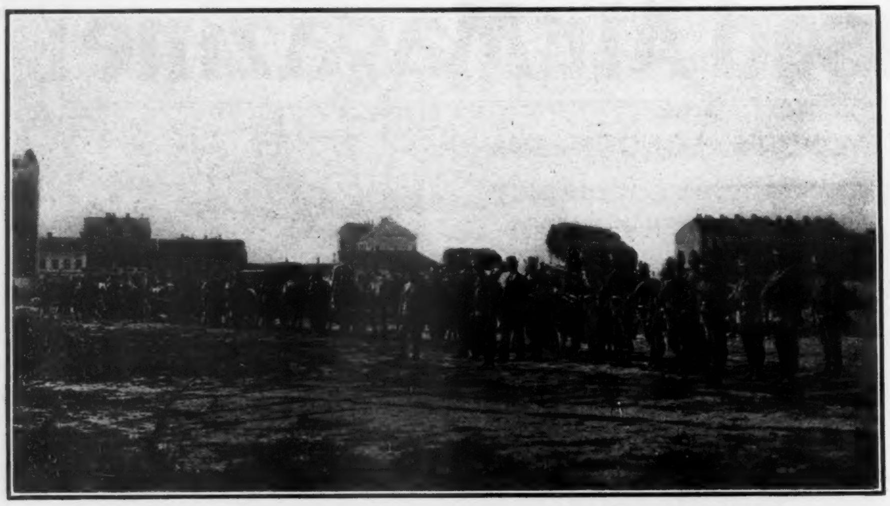
**IN THE course of the Great War much was heard of the "digging in" of armies on the Western Front and concerning their intricate and elaborate trench systems. The world learned little, or nothing, however, of the engineering feats incident to the warfare on the Southern Front. The Italians and the Austrians were enabled to make war on great mountain heights only by means of the air-propelled hammer drill. For three years the campaigns resolved themselves into the greatest drilling contest in engineering history, and mobile air compressors and rock drills were employed by the thousand.**

**This article is the first of a series on European compressed air engineering topics, and having to do also with industrial, economic and business conditions on the Continent and in the British Isles, which are to be published in this journal in the coming year. Materials, including many striking photographs, descriptions and statistics, were procured by the writer in the course of a five months' trip through the British Isles, France, Belgium, Luxembourg, Germany, Austria, Switzerland, Spain and Southern Europe. These materials were not collected hastily and the resulting articles will doubtless be found of interest to engineers, manufacturers and business men generally.—The Editors.**

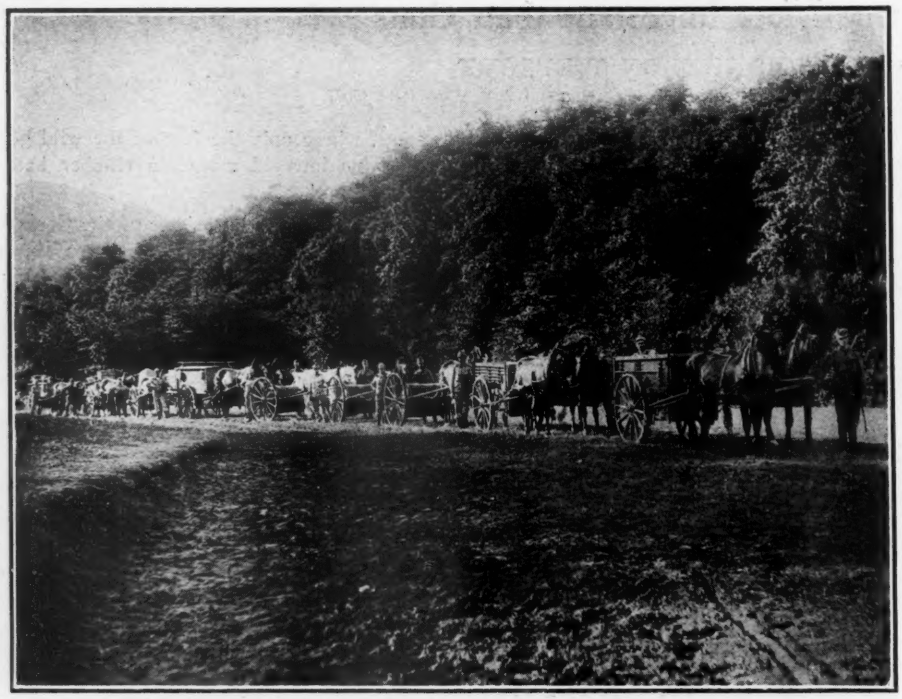
The waging of this phase of the Great War, between the two principal southern European countries involved, looked at purely from the professional engineering angle, presented the most serious difficulties. The larger part of the boundary line between Italy and Austria, marked by the Alps range, comprised a great natural barrier, one which had been regarded as a bulwark of defense by earlier civilizations, and one much relied upon by the ancient Romans. Both the Italian and Austrian armies in the war experienced great trouble in hauling up ammunition, food, and supplies. The altitude made breathing and physical effort difficult for soldiers. Aerial tramways, it may be noted at this point, were used in many localities, and with much success, in transporting supplies.

To provide shelter for the troops of both armies from shellfire, and meet other obvious military requirement, the use of pneumatic drills and compressors became of prime importance. A captain of engineers engaged in this mighty struggle told me that this long phase of the war between the two belligerents was really a "battle of the rock drill," to use his words.

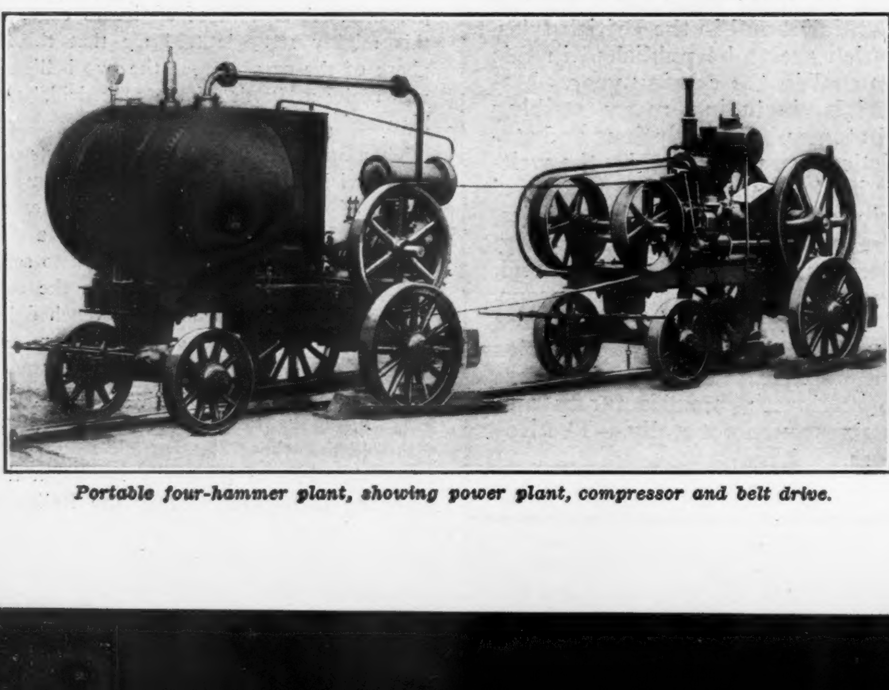
Thousands of people from many parts of the world visited last summer these imposing scenes of man's conflict amid the fastnesses of Nature. No mining engineer who is a visitor to South Central Europe should fail to see the remains of this giant combat. In the course of the war one heard much of trench fighting and digging operations on the western front, but nothing of the more collossal and imposing, and infinitely more difficult processes of "digging in," along the southern battlefronts. I was told that the present article would be the first public hint of the really monumental engineering feats performed by the Italian and



*First rock drilling squad about to start for the front in August, 1915.*



*A movable rock-drilling column on the march*



*Portable four-hammer plant, showing power plant, compressor and belt drive.*

Austrian engineers. Millions of tons of rock were blown up over a line 200 kilometers long.

Rock drilling made it possible for the contending armies to move up into the mountains to places never before visited by the foot of man. Roads and tunnels were constructed that remain today and which civilizations of centuries to come will find intact. It is not an exaggeration to say that the two armies in a given time accomplished the greatest and fastest rock-drilling job ever undertaken in the world's history. The tremendous amount of work done, and the nature of it can best be appreciated by a study of the photographs accompanying this article. As one engineer who was engaged, expressed it, the Simplon tunnel job of drilling was child's play compared to these military drilling campaigns, when great armies forced their way toward each other by means of compressed air.

The rock-drilling campaign lasted from the middle of 1915 until the Armistice was signed, a period of more than three years. At the climax of the Isonzo Campaign, late in 1915, my Austrian military informant told me, the telegram quoted at the beginning of this article was received at Vienna.

The campaigns between the two countries were waged, as much on one side as on the other, by means of portable air compressors, operating the hammer drills, and the Austrians developed a new type of light portable air compressor, constructed almost wholly of aluminum, of which some two score were built and put into commission before the close of the war. This type, which was extremely light, and which could be pulled on wheels by one man, was brought out too late in the war to have the wide use to which it was entitled because of its satisfactory performance. A description of this aluminum outfit, containing detailed facts, and with illustrations which the writer was able to procure, will appear in a subsequent issue of COMPRESSED AIR MAGAZINE.

It has often been said that the Great War was a remarkable teacher and trainer of human intelligence. It stimulated the mind to achieve results which few would have dared to suggest in peace times. Thus the giant wrestling between Austria-Hungary and Italy during the years 1914 to 1918 culminated in engineering achievements which might well be inscribed in red letters in the history of human progress in the technical field. The momentous struggle, as we have already indicated, took place where beetling cliffs and mighty parapets of rock stretched their snowy tops thousands of feet above the heads of the awed human dwarf. To overcome these obstacles in the least time and before the adversary succeeded in doing likewise, to cut a way through this sort of rugged territory, making it passable for the fighting troops and for the artillery, was the great goal.

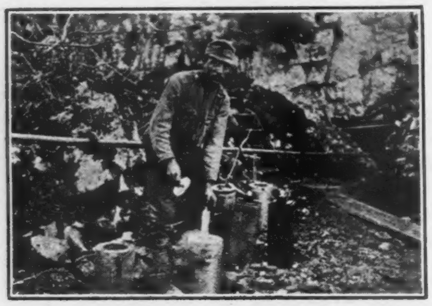
To indicate the extent to which the air compressor and the rock drill were used in warfare in Southern Europe, it is only necessary to consider some of the subjoined facts.

Austria alone made use of 1,600 compressors of an average capacity of 42 cubic feet of free air per minute. These were nearly all light

# Air Machinery Equipment Paramount in Warfare

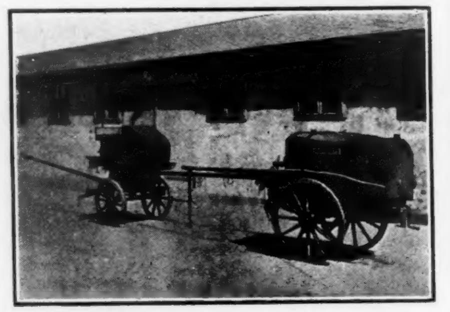
Photographs by courtesy of Engineers Division, Austrian Army.

*Fig. 1—Front line Austrian trenches dug with rock drills. Fig. 2—Austrian engineer squad engaged in trench building. Fig. 3—Three successive tunnels. Rock drilling work at the Italian frontier. Fig. 4—Ingersoll-Rand electric air drill at the Italian front driving a heading. Fig. 5—Blacksmith shop. Fig. 6—Dolomite formations in the Italian Alps.*



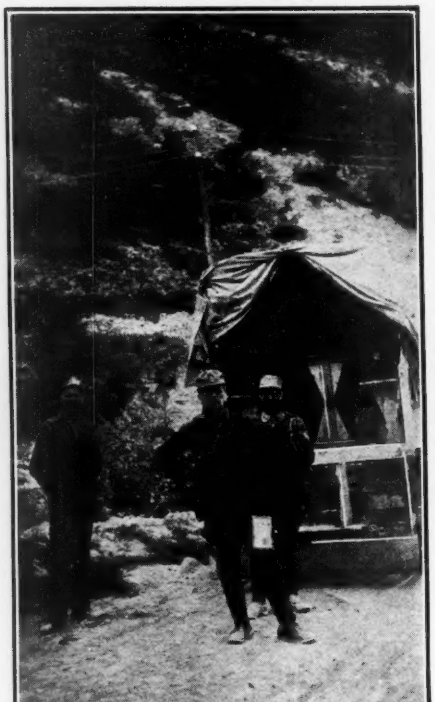
*Using liquid air as an explosive*

*Caves hewn in mountain side for stores and later faced with masonry.*



*A compressed air "flivver" engine generator aggregate of the Austrian 53rd rock drilling squad—two wheeled trucks.*

*Showing drilling of a dry flat hole with a Temple drill (I-R).*



*Capt. Desiderius Ernyei of the Austrian Engineers, rock drilling corps.*

*Drilling a wet hole with a "4 E" Temple drill (I-R).*

*Enclosed engine cart of the Nesseldorf type.*

machines, easily transported, and were sent to the front either knocked down, in boxes, or on wagon wheels in trains under the supervision of officers of the engineer corps especially trained in air practice, aided by soldiers who had also received special education in the use of these machines.

These compressors furnished the air, first and last, for a total of some 3,000 hammer drills, but not more than one-half of these drills was in operation at any one time, either because of repairs, storage, transit or the exigencies of the military situation. The average drill, I learned, required about 30 cubic feet of air per minute.

This pneumatic equipment, including compressors and drills, meant an expenditure by Austria of about $5,000,000. The air compressors were manufactured in Austria, Hungary, Germany and Switzerland; the drills came at first from factories in Germany, but later a special factory was established by the Austrian Army at Vienna to make the Demag type of hammer. This factory turned out nearly a thousand of these latter drills.

The Italian Army, meantime, having the United States to draw upon, was able to assemble approximately five times as much compressed air drilling equipment. The Austrians at the time, however, estimated erroneously that the Italians had only three times as many compressors and drills as were employed by the Austrian forces.

During the fierce fighting in 1917, when the Austrians were reinforced by the Germans with large units from the western war front, the Italians were driven southward, it will be remembered, to the Piave River. The Austrians then captured some 400 Ingersoll-Rand compressors, of "ER" and "NE" and "Imperial 12" types, all portable and driven by American gasoline engines. They also captured about 200 machines built by an Italian factory at Milan of one type, and still another 350 compressors built by a second Milan factory; also about a dozen Sullivan compressors from America. With this compressor equipment was captured 1,500 hammer drills of Ingersoll-Rand manufacture. Of the latter company's make, the Italians managed to save about 400 to 500 compressors which continued in the Italian service until the end of the war, in addition to hundreds of hammer drills.

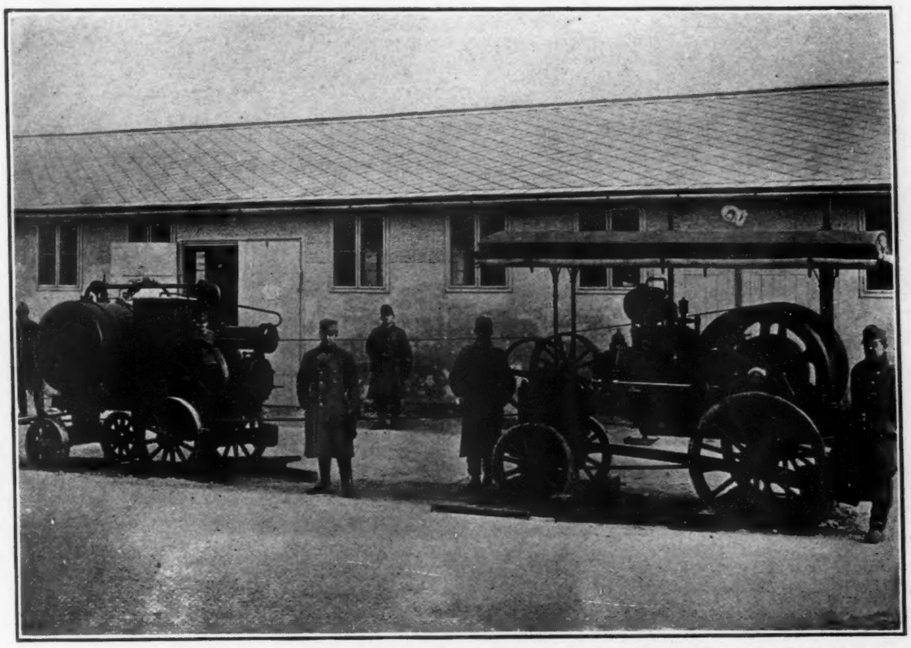
The Austrians repaired most of the captured equipment at shops in Vienna, whither the booty was transported, and later these machines were sent back into service against the Italians.

Each of the Austrian armies in the field in the Italian campaigns had its own technical corps, and in each technical corps was a special rock-drilling division. For instance, the Fifth Army, on the Isonzo, using about 500 hammer drills, with as many more in reserve, had about 2,500 men engaged on rock drilling alone, including two drill operators to each hammer drill, besides mechanics, electricians, blacksmiths and their helpers. These men were in charge of about 100 engineer officers.

The drills once arrived in the mountains were set at the work of boring into the rocky slopes, in order that roads, levels, housing accommodations, gun emplacements, supply houses, and last, but most important, trenches, could be provided, and mining operations conducted under the enemy lines. Long tunnels, about six feet in diameter, were driven forward under enemy positions, from which mines were exploded in some of the battles. The Italians were, of course, prosecuting exactly the same kind of operations with their superior equipment. It is noteworthy that the Austrians used liquid air to a considerable extent as an explosive.

Frequently when one of the belligerents was tunnelling toward the position of the opposing side, he would be able to hear hammer strokes of the enemy boring toward him. The Austrians and Italians both employed subterranean telephonic listening devices of the geophone variety. A hole would be drilled some five to eight metres ahead of the tunnel heading, and through this hole would be thrust a long pole at the end of which was fastened the listening device, connected with the rear by wires along the pole. As long as the enemy continued to drill, the miners felt safe and continued their own work, but when the enemy stopped his drilling, the miners would rapidly scramble out of their own tunnel, expecting momentarily that a mine would be exploded.

This was exacting and dangerous work for the engineer corps of either side. Sometimes tons of dynamite would be exploded at a time, and almost mountains of rock were sent skyward. The visitor can see today remains that



*Heavy compressor outfit for four hammer drills. A gasoline engine drives by belt the air compressor which is seen on its separate wagon carrying its air receiver and water cooling apparatus. Used in the Austrian Army.*

*Gasoline-electro outfit used by the Austrians to produce current for an electrically driven air compressor. The wagon can be split in the middle into two parts so as to be more mobile in rounding curves. This arrangement facilitates rapid movement.*

# Mobile Equipment, With Accompanying Tools

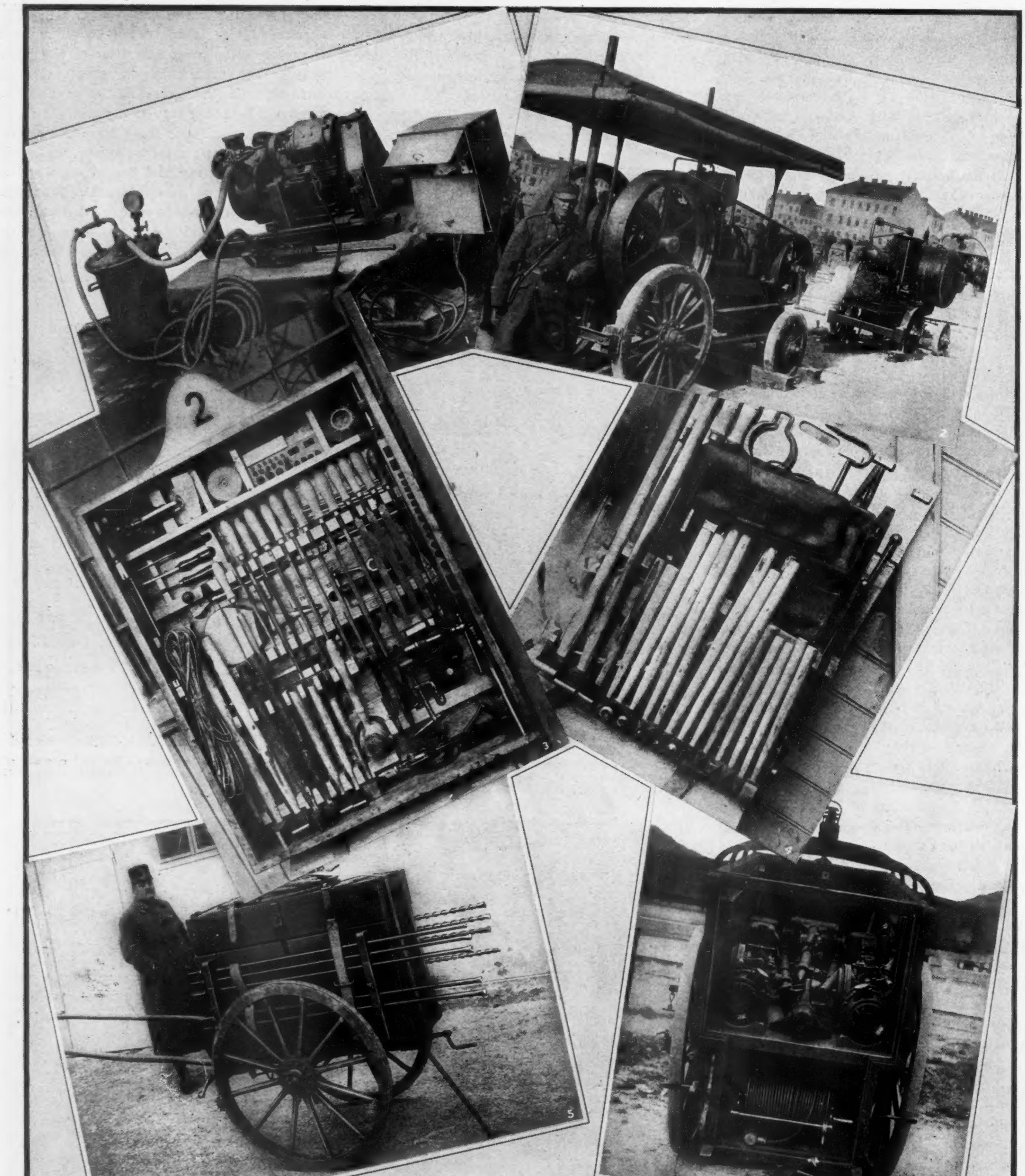


*Fig. 1—A sectional electric compressor with accessories, built by the Austrian Brown Boveri Works, a Swiss Company. Fig. 2—Three hammer plant with the same equipment as in Fig. 3. Lateral view. Fig. 4—Blacksmithing tools for Supply Cart No. 1. Fig. 5—Hose cart of an automobile compressor train (Skoda type) showing how steels were carried on exterior. Fig. 6—Rock drill Cart No. 2, open, showing how a column's electric drill was knocked down and loaded for transport.*

will be visible for centuries of the rock-drilling warfare in the Alps.

The drilling contests in which the two armies were engaged brought out some highly interesting comparative data on the performance of equipment utilized. Engineer officers made reports, of course, on the accomplishments of various kinds of pneumatic apparatus. In particular there has been uncovered since the Peace of Versailles one of the most notable tributes to air machinery products ever known in the history of the industry. It is an official Austrian Army report to Headquarters, written by two engineer officers and endorsed and countersigned by Archduke Karl, who was destined thereafter to become Emperor, succeeding Emperor Francis Joseph, who died in the course of the conflict. It therefore amounts to an imperial endorsement by the late enemy, the tribute being paid to the products of a leading air machinery house, the Ingersoll-Rand Company. The report in question, after describing compressors and hammer drill equipment captured at Corpomolon from the Italians, and comparing it with German and Austrian equipment proceeds as follows:

*"B. Drills*—The Ingersoll type of hammer drills as used by the Italians proved to be the best. The hammers are simply and easily served by unskilled laborers. The crown bit of the steels has proved a great success.

"Basing our judgment on these experiences we can recommend for further similar work:

"Setting up other drilling squads in similar arrangement to that of Drill Squad No. 23, but with the addition of the captured Ingersoll-Rand drills of lighter type, together with a complete repair shop under tent, with Leyner sharpeners. Also fixing of acetylene searchlights and mining lamps."

(Signed) SORTER, Commandant Engineer Lieutenant.

(Signed) HELMER, First Lieutenant Electrical Engineer, Trient Section.

9th June, 1916.

Below is the subjoined endorsement, six days later, by the Imperial Commander:

"The tunnel driving proves to be a superior achievement accomplished by officers and men. By virtue of this extraordinary technical feat by officers and men of the Sections No. 1 and No. 4 of the Drilling Squad No. 23, I have ordered that they receive proper citations in the Army Report."

(Seal and signature) Archduke KARL.

15th June, 1916.

The writer was able to obtain at Vienna excerpts of salient features from this report, and later translations of them, from the war records of the Austrian Army. The complete report, which it is unnecessary to reproduce in full, is entitled, *Engineering Report in Connection with the Motors and Rock Drills used at the Tunnel Driving at Cania die Mesolo,* which latter place is in the South Tyrol.

These sections of the report, however, may be of interest to our engineer readers, as a matter of history and record, and they are therefore reproduced:

*"A. Driving Motors.*

"I. 30 HP small two-wheeled truck with driving motors of the firm of Prager, with direct-coupled direct-current dynamo, feeding a direct-current motor with air compressor driven by toothed-wheel gear.

"II. Two "aggregates" arranged in the same way but of 21 HP each.

"III. Two small two-wheeled trucks of the Siemens-Schuckert Works consisting of: alternating current generator with Enger machines, both belt-driven by a 10 HP four-cylinder gasoline motor of Daimler make.

"IV. Drilling squad No. 23 consisting of: two similar machine aggregates with the necessary accessories; the small two-wheeled truck consisting of a four-cylinder gasoline motor, two cylinders of which only worked as a motor, the two other cylinders as air compressors.

"V. A belt-driven four-cylinder gasoline motor for air compressor of Ingersoll-Rand Co. make, with all necessary accessories; acquired Italian booty from Corpomolon; efficiency of this motor about 16 HP.

"VI. A similar motor as afore-described, but rated at 16 HP; acquired booty; Italian machine of Coston.

"The above eight driven machines were working, as per minutes, on the 30th May, 1916, 8 a. m., with the exception of the two last Italian and American machines respectively, which, owing to a required repair started work on the 4th June and 6th June respectively.

*"B. Rock Drills.*

"At the tunnel driving three systems of rock drills were used. On the average there were working at the same time:

"Four pneumatic hammer drills, Flottmann system.

"Five electrical a. c. Siemans-Schuckert percussion drills.

*Trenches on the Italian frontier dug by machine drilling.*

***Showing gasoline engine driving generator set which is connected with switchboard containing ammeter, voltmeter, fuses, etc.***

*Left—Training soldiers in the operation of hammer drills. Right—A three hammer plant with a Flottmann compressor and Bruenn-Koenigsfeld gasoline engine.*

"Two pneumatic Ingersoll-Rand hammer drills.

"There were also used, where necessary for small work, hand drills.

"As a resumé it may be said in connection with the safety and useful appliance of these machines the following:

"It is quite natural that repairs would be necessary, considering how greatly these machines were taxed working day and night. A suitable repair shop was not at disposal and it would have been impossible under the prevailing circumstances to get one installed; all that could be done, therefore, was to see that spare machines and spare parts were constantly and regularly delivered. A further difficulty was the providing of cooling water under the constant fire of the enemy armies.

*"A. Driving Machines.*

"The two-wheeled truck drills, as mentioned under Item III, of the Siemens-Schuckert Works, gave a good result; however, they did not seem to stand a long period of work. More suitable for the job showed themselves the driving machines of the drilling squad No. 23 owing to their simple construction and working.

"The machines under items I and II required careful attendance, owing to their complicated arrangement, by skilled laborers. The Italian and American machines are, apart from the fact of their neglected state in which they were taken over, very useful, and in consequence of their simple construction, easily served."

## LUBRICATION OF AIR DRILLS

THE IMPORTANCE of lubrication in the economical operations of machines of various kinds has gradually won recognition, says an editorial writer in a recent issue of *Engineering and Mining Journal.* In steam engines, pumps, and particularly in high-speed machinery of all kinds, efficient lubrication by a system which will be continuous in its operation and almost entirely automatic is an accomplished fact. In hard-rock mines the air drill is pre-eminently important. With the former type of piston drill, lubricants were applied at two points. One was at the rotating mechanism. By removing a screw plug the lubricant could be applied at intervals, the movement of the mechanism carrying the oil to all parts. The other was by means of a small cup placed on the air pipe close to the valve chest. By filling this with lubricant and opening the valve, the lubricant was swept into the valve mechanism and carried into the cylinder. By applying the lubricant at sufficient intervals, the drill could be efficiently operated. Everything, however, depended upon the alertness of the drill runner.

With the advent of the hammer type of drill a high-speed machine, the method of lubrication just described was inadequate. Some of the earlier and, in fact, fairly successful types of hammer drills failed to give all the service that was possible, on account of this all-important lubrication. Inadequate lubrication increased power requirements and repairs. A system that would be continuous with only occasional attention on the part of the drill runner was essential.

In the development of hammer drills the manufacturing companies did not overlook this important feature of lubrication. An exhaustive investigation of available lubricants has been made, and exact specifications for suitable lubricating media have been determined. The kinds of lubricant suitable for different machines and purchasable on the market are specified. Drilling machines as they are sold are provided with a tag, which gives definite information as to the kind of lubricant and the method of lubrication best suited to the machine. The waste in power, labor, and repair parts in a mine employing twenty-five to fifty machines or more, due to neglect or carelessness in the selection and use of lubricants, is undoubtedly large unless provision is made to prevent such losses.

The condensed epitome of information on the subject of lubricating drill machines which may be found on the tag accompanying the drill when it is shipped by the maker indicates that a great deal of thought has been put into the preparation of this card. Back of the card there was an immense amount of research and experimentation, to evolve the important conclusions which appear on its face. Just a tag tied to a machine—but how often are the conclusions placed on this card carried out? We are well aware that many mining companies have gone into the study of air-drill lubrication and its application with the same thoroughness that has characterized their other operations. But do all drill runners, master mechanics, superintendents, and purchasing agents realize the endless experiments required to secure this important information and do they take advantage of the knowledge which drill manufacturing companies have so generously and freely given them?

## HIGH WIND VELOCITIES

Mr. W. R. Gregg reports in the *Monthly Weather Review* that during a pilot-balloon flight over Lansing, Mich., on the morning of December 17, 1919, a wind of 83 meters per second (186 miles an hour) was observed at an altitude of 7,200 meters (about 4½ miles). So far as known, this is the highest wind speed ever observed in the atmosphere of altitudes less than 10 kilometers. Exactly the same velocity was recorded by an anemometer on Mount Washington in 1878, but anemometer readings at high velocities are always much in excess of the true speed of the wind. At great altitudes much higher velocities undoubtedly occur. Cirrus clouds have been observed to move at speeds of 200 miles an hour and upwards, and the drift of meteor trails seem to indicate that the highest winds of all occur far above the cloud level.

# How Air Magically Unloads Waterborne Grain

## Floating Pneumatic Elevators at Port of London Discharge Cargoes in Midstream, Saving Time and Money—No other Method Can Successfully Compete—A System which Will Become Universal

By BEN K. RALEIGH



THE LAST months of 1920 saw England, dependent on the outside world for food for its population, busy receiving the great Eastward crop movement from America, with occasional contributions from Australia. At that time there came up the Thames, under its own steam, the *Cecilia,* a grain ship out of Philadelphia. Every hold was chock-a-block with yellow kernels harvested from the fields of Nebraska and Kansas. The pilot took the vessel around the dangerously sharp turns of the twisting Thames until the dome of St. Paul's became visible.

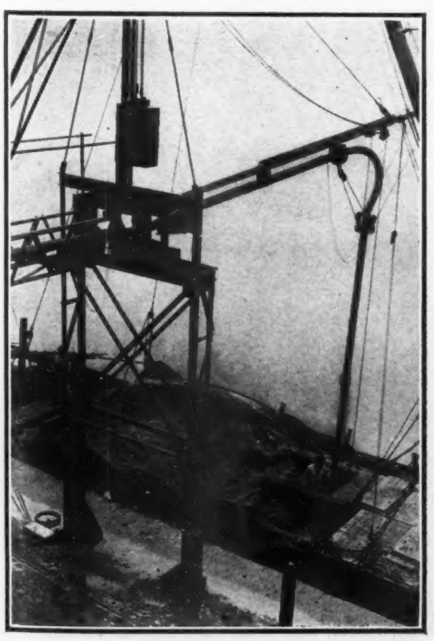
On the nautical left hand side, as an American Navy Department official once dubbed it, lay Greenwich, where the seconds are born, where they grow up into husky minutes and decrepit hours, and where they die after a flight around the globe. Here a launch put the owner's agent on board.

The boat, still nosed its slow way along, and the pilot, his eyes on his landmarks, inquired alongside which grain elevator he should berth the ship. The captain stood near, puffing his pipe contentedly. Against the sky line now, rising in front of St. Paul's great dome, could be seen the grain elevators, spaced along the great docks.

The owner's agent said, rather cheerfully the captain thought, that the crop movement was so extremely heavy just then that every berth at every elevator had been preëmpted. That news struck the captain forcibly. He noted many ships moored in midstream, all well down in the water, spelling to him cargoes waiting to be discharged. He thought of his arrangement of a bonus for a quick turnaround and regretfully counted it lost. He had a sudden vision of mounting port dues while his ship lay in midstream for days and days,—perhaps, who could tell?—for weeks. He thought of the fixed charges, the wages of crew and their sustenance while the ship rocked idly in the Thames, of the money which the ship might be making if she got in and out of the Port of London quickly, of the loss that would keep running up while she loafed there and "ate her head off." He felt, he told me later over a well relished pewter mug of "mild and bitter" in "The George and Vulture," that there was a reasonable gust of anger brewing over the head of that cheerful owner's agent.

**THE PNEUMATIC elevator system saves money and time—which is money in these days:**

- **No trimming necessary. This means a saving of time and a notable saving of labor and labor's pay.**
- **The pneumatic discharge is distinctly healthier for the workmen operating the elevators.**
- **The amount of floating dust met with in the old-time system is not present.**
- **By passing the grain through pipes, along with a strong current of air, it is found that if the temperature of the grain has risen during the sea voyage, the effect is to improve the condition of the grain and so add to its marketable value.**
- **A destructive effect has been noted on such pests as weevils and mites. The ravages of these pests are abated by the air treatment.**



*Unloading grain from coastal barge*

"I felt then," said he, holding up a short, brown finger to command attention to his analysis of self, "I felt then—not now mind you—but I felt then that a chap who could cheerfully bring such news would sing 'Turkey in the Hay' and do a break-down at the funeral of the maternal progenitor of the lady to whom he was only related by marriage."

But the owner's agent hadn't been hired because he could be cheerful over news adversely affecting his employer's interests. The captain, himself a "mild and bitter," grinned as he spun the yarn of the unloading troubles that had confronted him.

"There was I calculating that it would cost us nigh on to $2,000 for every day we lay in the Thames, and counting the boats moored ahead of us and figuring that, taking our turn, we would be lucky to get away in five days, when the agent asked me whether I could see a ship sticking out around the curve of the next bend. I said 'Yes' fairly shortly.

"'Notice anything peculiar about that ship?' the agent wanted to know. I said there was a tug or a barge or a dredge or some other queer contraption made fast to her side. 'Exactly,' said the agent to me, 'it's a contraption and a new-fangled one, and you are going to love it before you're through with it. And you are going to forget all those bad dreams you're having. You are going to get out of the Port of London, as the American doughboys said in purest French, toot sweet, for I'm going to have the sister of that contraption operate on the *Cecilia.*'

"I will get my bonus. I'm sailing for home tomorrow. I came into a port crowded with ships all waiting to discharge. If they had grain for a cargo they discharged in midstream and took on whatever return cargo there was waiting for them and were off to whatever port of the Seven Seas they called their own. Minimum port dues, minimum discharging expense, minimum waste of time in port! I get the bonus and I want to come to the Port of London again with grain, for its the new-fangled contraption that did it!"

*Unloading barley to London brewery*

*The operator and his work*

This sounded worth while. A trip on the top of a 'bus to that part of the Thames flowing past Albert Dock landed me in the hands of an ancient waterman with a leaky boat.

"Aye, aye, sir, there's one of the floating h'elevators at work just down stream," he said. "They haven't no names, but we calls them 'Pride of the River' and 'Boatman's Friend'. You see, sir, when a ship moors in stream the crew just can't step ashore over the dock side and that means more sixpences for the poor boatmen, whose business was most dead until the h'elevators came along."

The boatman sculled skilfully alongside the elevator, a trim looking contrivance, supported by pontoons. The engine worked almost noiselessly. The hatches of the American wheat boat were off and the elevator had just put her suction pipes aboard and down the holds. There were no men, with damp rags tied around nose and mouth, to protect lungs from dust and chaff, shoveling grain into the mouth of the pipe, as is necessary when discharging by the method of the old mechanical endless-chain of buckets.

The pipe mouth rested on the surface of the wheat, the suction power was turned on and the wheat, without dust, fuss, flurry, or shoveling simply melted away.

Inch by inch, in both holds, it sunk beneath the pneumatic suction onslaught, pouring a thick yellow stream of life out into the container on the other side. As the wheat sank, the pipes magically extended themselves on the telescope principle. This particular ship had a cargo of 3,000 tons of Nebraska wheat. She anchored in the Thames on Tuesday at 10 a. m. The elevator was alongside at 10.30. Work was stopped at six in the evening. At seven the next day the work recommenced. On Friday between 9.30 and 10 o'clock in the morning the boat was clean of wheat and was ready to go about her other lawful occasions. Just a trifle more than thirty hours to do the whole job without fuss, worry, dirt, disturbance; everyone in a good temper and no frazzled nerves. A nice, quick, business-like piece of work brought about by the intelligent application of the power of air to the ordinary humdrum things of life.

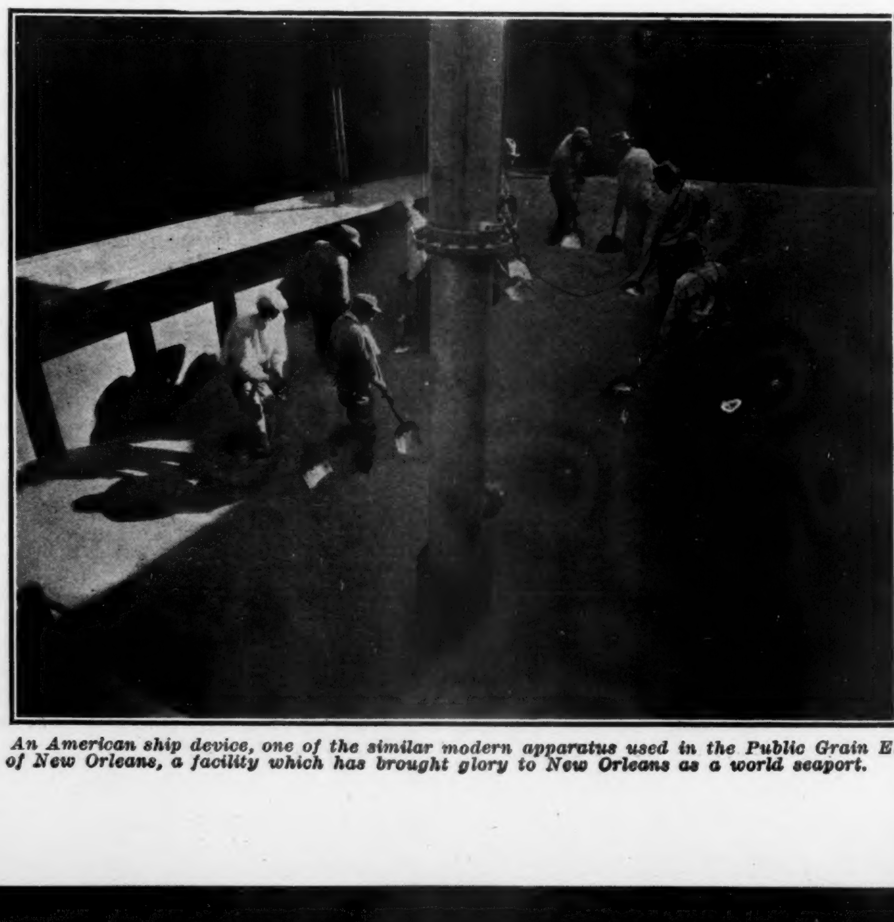
Had the elevator crew worked in shifts day and night the ship that arrived at 10 a. m. on Tuesday would have been free of her wheat by 4.30 p. m. the next day. There has been no need for such a performance yet, but the crisis may arise and if, and when, it does, the pneumatic suction floating elevators are there to cope with it and vanquish it.

The officials of the Port of London Authority furnished Compressed Air Magazine with the technical details. There are two of these pneumatic grain conveyors now faithfully and efficiently serving the port of the metropolis of the British Empire. Their service has been found so satisfactory in every respect that it is more than probable that the near future will see four more in operation. The Port Authorities of the other great English seaports have their eyes on the development and it is likely that Liverpool, Manchester and other cities will join in the progressive stride. England then, if other wheat importing nations do not follow suit, will always be able to command wheat cargoes while other lands go hungry, for the ship owners will prefer to send their boats to the ports where they can be assured of the speediest kind of unloading, and a quick turn-about, with all that that means in saving and profit-making. But the rest of the world that is not already equipped will be forced to adopt the system in self defense.

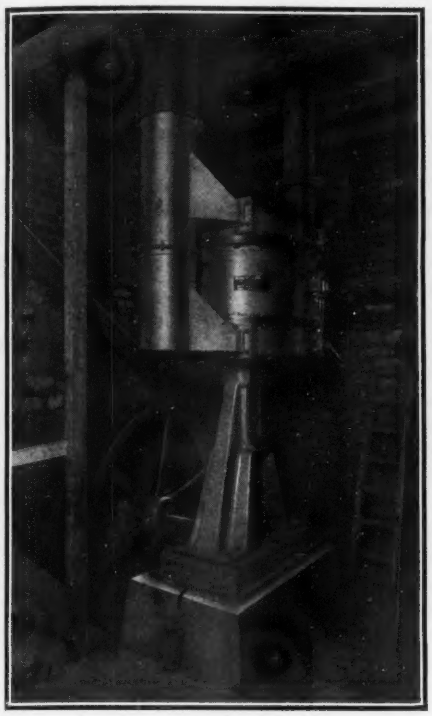
The two powerful floating pneumatic elevators put into service by the Port of London Authority, of which C. R. S. Kirkpatrick, M. Inst. C. E., is chief engineer, have a maximum capacity of about one hundred tons per hour each when working in wheat. Each complete elevator is the product of four separate contractors. The pontoons on which they float, were built by Messrs. Edwards & Co., Ltd., of Millwall; the grain ducts, cleaners, elevators, etc., by Messrs. Henry Simon, Ltd., of Manchester; the turbo exhausters by Messrs. Fraser & Chalmers, Ltd., of Erith; and the engines by Messrs. Petters, Ltd., of Yeovil.

Each vessel has a length of 60 feet, a breadth at gunwale of 30 feet, and, at chine, of 27 feet, and a moulded depth of eleven feet, six inches.

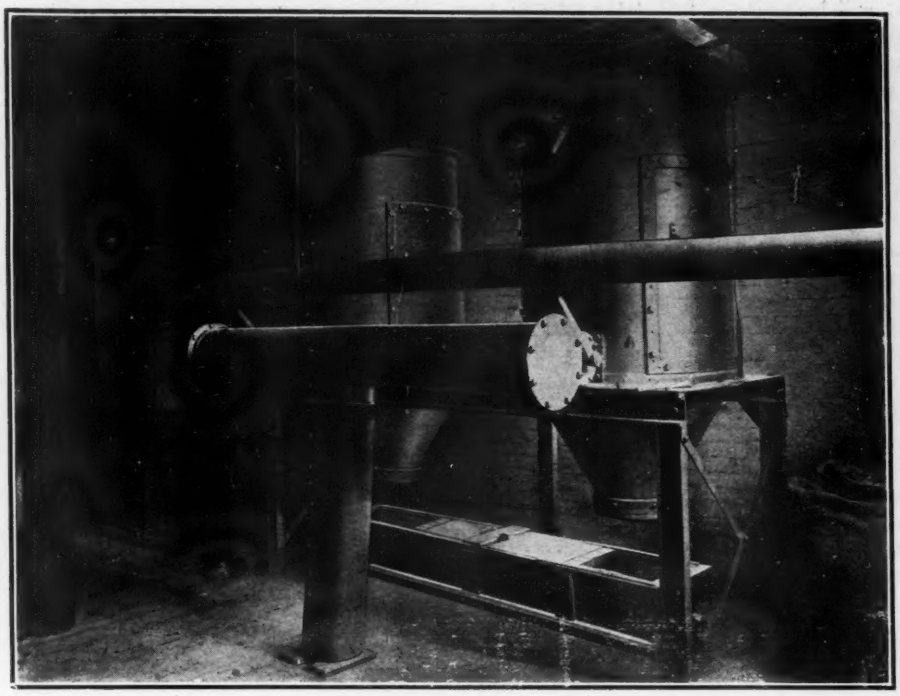
The noticeable feature is the adoption of high speed turbo exhausters driven through gearing by oil engines, in place of the more usual reciprocating exhausters, direct coupled to steam engines. The prime movers employed are Petter four-cylinder vertical two-stroke cycle, crude oil engines, each designated to



***An American ship device, one of the similar modern apparatus used in the Public Grain Elevator of New Orleans, a facility which has brought glory to New Orleans as a world seaport.***



*Reciprocating vacuum pump*



*Receiving and discharging apparatus*

develop 220 brake horse power at 2,700 revolutions per minute.

The principle involved in the pneumatic portion of the plant is the production by means of an exhauster of a part vacuum in a suction pipe line and a receiving chamber. The air rushing into the free end of the conveying pipes carries the grain with it into a receiving chamber, from which it is discharged through a control valve and thereafter is dealt with mechanically.

In the present case the air is extracted from the vacuum chamber by means of a Fraser & Chalmers Rateau turbo exhauster. The air is, of course, heavily charged with dust and dirt which is to a great extent removed by a Cyclone extractor, from which it passes into the turbo exhauster.

This turbo exhauster was designed to suck in 8,500 cubic feet of air per minute, the air being measured at a vacuum of nine inches of mercury—with a barometer of thirty inches—and at a temperature of 60 degrees Fahrenheit. The delivery of the air is free to the atmosphere. The exhauster is of the single flow type and its horizontal air inlet is twenty inches in diameter. The air is compressed from a nine-inch vacuum to barometric pressure in four stages, each stage consisting of a centrifugal impeller. The pressure increase per stage is greater as the air progresses from inlet to delivery. All the impellers are of the same diameter, but the width of the last two varies from that of the first two.

A greater compression per stage nearer delivery is due, of course, to the increasing density of the air. The increase of pressure in the impeller is noticeably greater than the increase in the diffuser.

The delivery of the turbo exhauster has a diameter of fifteen inches and is situated on the horizontal joint. The impellers are of the centrifugal type. The main discs are machined out of steel forgings and are bored to fit the shaft, on which they are secured by means of keys. The blades are riveted to the main discs on one side. On the other side they are riveted to a covering side-plate, which on the inner periphery is strengthened by steel rings. Between the impellers are inserted distance rings which are also keyed to the shaft.

The balancing piston which is provided after the fourth stage to counterbalance the longitudinal thrust exerted by the impellers is of the cylindrical type and is provided with labyrinth packing. This packing is formed partly by soft brass rings, caulked into a sleeve fixed to the blower casing. The casing is split vertically into several sections and the whole casing is also split along the central horizontal line.

In order to prevent leakages between the stages, packings of the labyrinth type are provided on the suction and delivery side of each impeller. At the inlet of the casing there is packing of the same type to prevent air being sucked in from the engine room. There is a similar gland on the delivery side.

The guarantee for the performance of the turbo exhauster was that the power required to drive it, when sucking in 8,500 cubic feet of air per minute at nine inch vacuum—barometer thirty inches—and at sixty degrees Farenheit, would be 220 brake horse power at the exhauster coupling. The power actually required in performance is ten per cent. less than the guaranteed figure. The normal speed of the exhauster is 2,700 revolutions per minute.

Each of the two elevators now performing at the Port of London is fitted with two vertical suction pipes, equipped with nozzles of the Reform type, which dip down into the holds of vessels. The pipes telescope to adjust to the increasing depth of the hold as the grain diminishes under the impulse of the pneumatic suction power.

"What," I asked an engineer of the Port of London Authority, "have the floating pneumatic elevators demonstrated?"

The answer was a volume in seven words, and the highest compliment that could be paid to the pneumatic system in these days of high costs and labor scarcity. They were:

"Economy in labor and ease in handling."

"If," said one of the Port of London Authority engineers, "publicity is to be given to our floating grain elevators in Compressed Air Magazine we shall know now to prepare for an influx of investigating committees from ports all over the world. And once they see the elevators at work, the economy of operation and the saving in costs all down the line, the system will be adopted by every grain importing port everywhere. It will then be a case, as they say in America, of 'everybody's doing it.'"

## ENGINEERING PHASES OF PNEUMATIC ELEVATORS

*By ROLAND H. BRIGGS*

NO SYSTEM of unloading and conveying grain can successfully compete under ordinary conditions with the pneumatic method, and in general it may be claimed that the more difficult the unloading problem becomes, the greater is the success of the pneumatic equipment compared with other systems. There are two main reasons for the success of the method, the simplicity and the portability of the plant used. In the majority of cases use is made of a vacuum instead of increased pressure, the general rule being that where the grain is to be conveyed from a number of external sources to a central point the suction system is used, with a vacuum of about one-third of an atmosphere, but that where the grain is to be delivered from a central store in various external directions, blowing is resorted to.

It will be understood that the general features of the equipment are identical in both cases, and consequently in this article it will be sufficient to describe the suction plants only. Further, although only grain will be mentioned as the material conveyed, with suitable modifications, the plant may be used for malt, sugar, salt, charcoal, chaff, chemical manures, cement and any other similar granular substance. These substances present so many varied features and such peculiar difficulties, that the universal success of compressed air on any duties where the suction and delivery points are not more than a thousand feet apart is all the more remarkable.

One of the most usual duties to which the pneumatic conveyor is put is in unloading grain from a ship to a number of barges, or from a ship or barge to the top floor of a mill or brewery. Most of the grain used in Britain has to be imported from the American Continent or elsewhere. The amount to be unloaded annually is therefore very great indeed, and where mills are served by water transport, by canal or river, the unloading must be carried out twice, first from the ship to the barge, and subsequently from the barge to the mill. If a thousand foot pipe-line will connect the hold of the ship with the delivery point in the mill or brewery, it is of little importance what intervenes. It is easy to carry a pipe line over a river, railway line, street, or intervening row of warehouses, and the flexible connections at both the suction and delivery ends of the pipe line give the apparatus a considerable radius of operation.

A stationary air pipe line is run from the warehouse or the mill to the dock side. Even this stationary line is in some cases fitted with universal joints in places, which allow of a certain degree of movement. At the dock end of the line the flexible connections allow the operator to empty the grain from any part of the hold or holds in the ship, so that trimming is eliminated, at any state of the tide and in any weather with equal convenience. At the delivery end the stationary pipe is tapped at various points for flexible connections, so that the grain can be delivered at the exact point in the granary or mill at which it is required, or evenly distributed over the whole floor, without any hand labour except the moving about of the flexible tube. The air-pump or compressor is situated in the warehouse, so that there is no mechanism whatever near the docks except the suction end of the pipe or pipes.

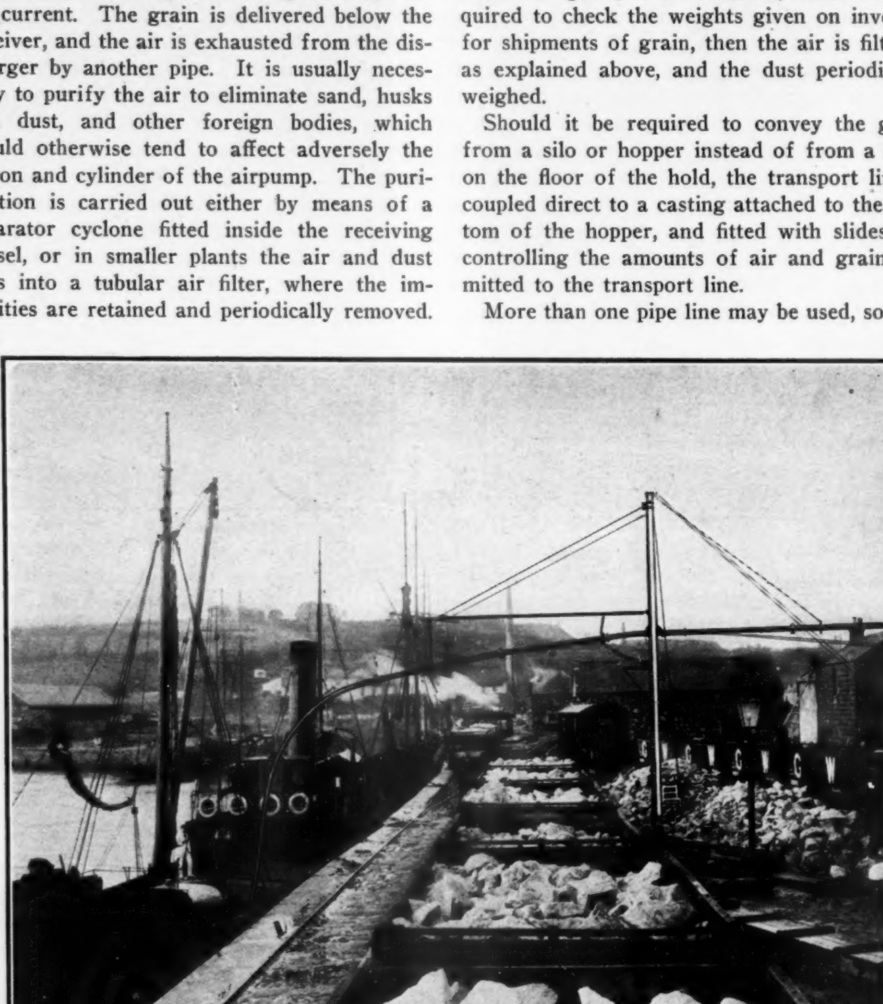
The suction conveyor is dustless and noiseless, and it is on the question of dust that it is in general superior to the blowing conveyor, although under special conditions and for moderate capacities, the latter has some advantages. It is claimed that a very high average hourly efficiency can be obtained by the use of the pneumatic conveyor, as compared with the bucket conveyor of equal nominal capacity, and that the pneumatic pipe-line is lighter and much more adaptable than the apparatus of the bucket elevator or band conveyor. In general modern practice with an efficient air pump the power consumption of a pneumatic plant with about 50 ft. of vertical pipe and 150 ft. of horizontal should not exceed about 1 H. P. per ton per hour.

The grain is drawn in by the air rushing into the pipe to fill the part vacuum, and is carried by the air through the pipe to the point of discharge. Here it reaches a receiver and discharger, which separates the grain from the air current. The grain is delivered below the receiver, and the air is exhausted from the discharger by another pipe. It is usually necessary to purify the air to eliminate sand, husks and dust, and other foreign bodies, which would otherwise tend to affect adversely the piston and cylinder of the airpump. The purification is carried out either by means of a separator cyclone fitted inside the receiving vessel, or in smaller plants the air and dust pass into a tubular air filter, where the impurities are retained and periodically removed. After this cleaning process the air is taken into the vacuum pump, and is subsequently exhausted outside the building.

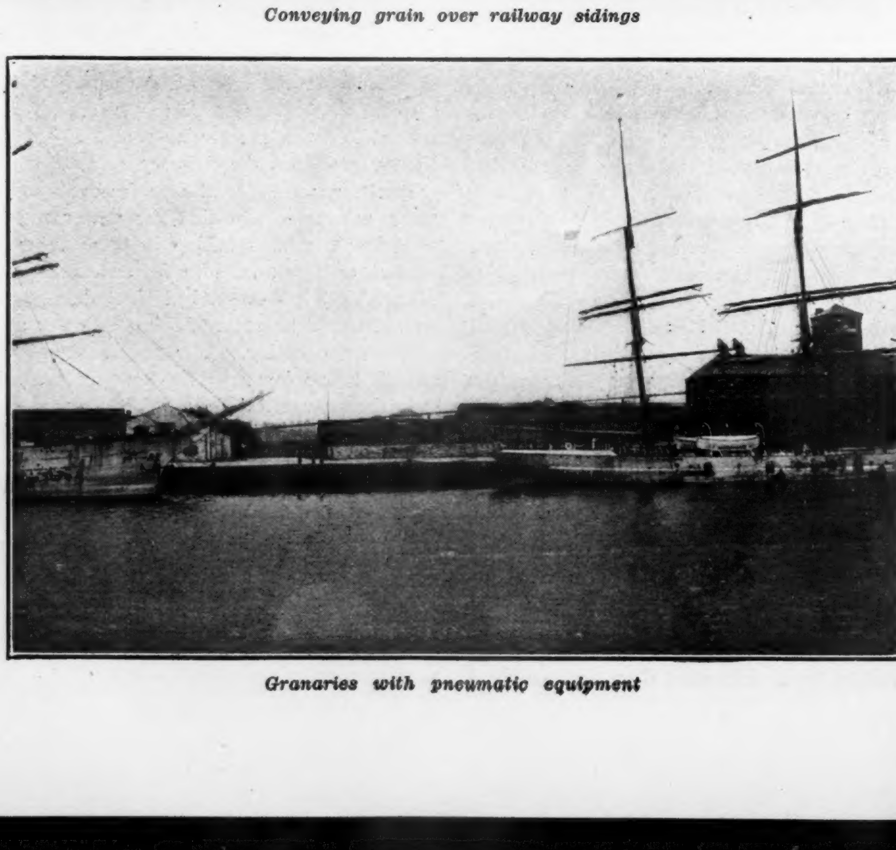
When the retention of the dust is of no importance, a cyclone is used. But when it is desired to preserve the dust which has been present in the grain, as for instance, when it is required to check the weights given on invoices for shipments of grain, then the air is filtered as explained above, and the dust periodically weighed.

Should it be required to convey the grain from a silo or hopper instead of from a heap on the floor of the hold, the transport line is coupled direct to a casting attached to the bottom of the hopper, and fitted with slides for controlling the amounts of air and grain admitted to the transport line.

More than one pipe line may be used, so that



*Conveying grain over railway sidings*



*Granaries with pneumatic equipment*

several buildings are connected to the discharger, and from these main pipe lines branch lines may run, so that a wide area is covered. A pipe switch is fitted at the point where each branch joins a main line. By means of this switch, three separate side positions may be connected with one point on the main line, and the action of the switch is such that when any one branch is connected with the main line, the other branches are automatically disconnected.

In the pneumatic blowing plant the filter and separator are dispensed with, as the air does not pass into the compressor. An apparatus called a feeder passes the grain into the transport line, this feeder being in effect a rotary air lock, and the grain is then blown through the pipe line to the point of delivery.

If the dust cannot be allowed to escape freely, as in a brewery, the transport line may end in a cyclone, in which case the grain falls out of a spout at the bottom of the vessel, and the dust-laden air is conducted away to the outside of the building or to a dust chamber. A rotary blower is sometimes used instead of a compressor where the distance to be covered and the hourly capacity of the plant are both low, but the compressor is to be recommended because of its higher efficiency.

Many different models of these pneumatic grain conveying plants are made to meet the varying conditions and duties which occur in practice. Floating plants are constructed for unloading ocean-going steamers into barges in port. The floating pneumatic plant is brought alongside the steamer by a tug, and work can then be immediately started, as the plant is entirely self-contained. Plants of this kind can be made of any desired capacity, a usual size being 200 to 250 tons per hour. The vacuum pumps are constructed to pass dusty air without wearing the piston and cylinder unduly, and the valves are designed for accessibility and to offer the minimum resistance to the passage of the air. The equipments shown in the various illustrations were designed and constructed by Messrs. Robert Boby, Ltd., of Bury St. Edmunds, England.

It will be understood that the type of pneumatic conveyor in largest demand is the stationary plant for delivering water borne grain to the upper floor of a mill or brewery, but other models include the floating equipment described above and a mobile unit, which was constructed for the Government during the War. This plant was designed to unload 30 tons of grain per hour from the hold of a ship and to deliver this amount to railway trucks standing 100 feet away. As the equipment was constructed under war conditions, use had to be made of the standard railway trucks, which necessitated the use of a blower. If a little more latitude had been allowed and the low trolley type of truck used, and a pump installed instead of the blower, the capacity of this equipment could have been increased to 50 tons per hour, and designs of this modified plant had been prepared when the signing of the Armistice put a stop to the work.

The special feature of this plant is that it can be sent by rail to any port where a grain ship is due to call, and the erection of stationary plants at each port is thus rendered unnecessary. In the standard model the grain is drawn from the hold of the ship through a 12 ft. length of flexible pipe, up 30 ft. of vertical pipe, round a bend and along six 12 ft. lengths of horizontal piping. At the top of the pipe there is a ball joint, so that the whole of this pipe can be swung in any direction to increase the area covered by the nozzle.

*Unloading small craft*

A second ball joint is located in the horizontal pipe line, so that the end of this line can be raised or lowered to suit the varying height of the grain in the hold. This horizontal line is supported on trestles, and at the end there is still another ball joint, to allow some vertical movement for any differences of level which may exist between the railway trucks and the edge of the quay. A small port in the pipe can be opened to admit air to clear a blockage, if one should occur.

The grain is admitted through the roof of the receiving chamber in the filter truck, and the speed of the air at this point is so much reduced that it will no longer carry the grain, which is deposited on the bottom and enters the discharger, which is a bucket wheel making an air joint with the chamber. The grain then passes down a chute to a short band conveyor, which takes it to the elevator at the end of the truck. This elevator delivers the grain to the standard dock grain trucks, where the grain is sacked and weighed for transport to the mills. The bucket wheel is driven by a friction clutch, so that no damage can occur if large hard substances should be caught in it by mistake.

The air passes from the receiver to a filtering system, consisting of a nest of canvas tubes, which are cleaned as required by a shaking device, for which operation they are isolated by means of special valves. A band conveyor collects this dust and carries it to the elevator, where it may be returned to the grain, to make the weight tally with the weight originally given. The filtered air passes into the second truck, where the blower, petrol engine, and gearing are located. Gear driven counter shafts from this engine drive the grain discharger, dust bucket wheels, dust worm, band conveyor, and the two elevators.

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The former Chairman of the War Industries Board of the United States, Mr. Bernard M. Baruch, received recently from Mr. Baker, Secretary of War, at the direction of President Wilson, an award of the Distinguished Service Medal. The President in a letter praised Mr. Baruch's leadership of the Board. At a reunion dinner of the board, at which the award was made, Mr. Baruch declared that final determination of Germany's reparation to the Allies was of compelling importance, since Germany's great consuming markets could not be thrown open again to the world until that country was stabilized through a definite settlement of the reparations question.

*Unloading two barges simultaneously*

## 45,500 MILES OF OIL PIPE LINES IN UNITED STATES

*By C. P. BOWIE*

Pipes for conveying oil are laid on the surface of the ground, or at a depth varying from 18-in. to 3 ft., and the main lines are generally 8-in. diameter. The pipe joints are threaded and the pipe must be capable of safely withstanding an internal pressure of 2000 lb. The pump stations are from 1½ to 90 miles apart, varying with the grades and the viscosity of the oil.

It is estimated by the U. S. Geological Survey that the total mileage of oil trunk lines in the United States today is approximately 34,000, and that the gathering systems, which are a fundamental part of the trunk systems, aggregate about 11,500 miles in length, making a total of 45,500 miles. At the time most of the lines were constructed, the average cost per mile based on 8-in. pipe was about $6,500. The cost of the average pump station at that time varied from $130,000 to $250,000.

The difference between the published pipeline tariff-rates and the railroad rates for shipping crude oil has always been so large that refiners and producers, even though they have no pipe-line systems of their own, cannot afford to ship by rail, except for comparatively short distances. The pipe-line rates, although greatly increased in recent years, are still much lower than those charged by the railroads for tank-car shipments.

The average distances between pumping-stations in the Midwestern and Eastern States is about 35 miles, while the average distance between stations in California, where a relatively thick viscous oil is handled, is about 12 miles.

The equipment of a pumping-station depends primarily upon the quality and quantity of the oil to be handled. It depends also, to a certain extent, upon the fuel and water supply. Equipment is usually provided in excess of ordinary demands, so that there is always in reserve extra pump-power to meet unusual demands, thereby avoiding shut-downs where repairs are needed to pumps and boilers. The pumps are designed to deliver through an 8-in. pipe-line approximately 30,000 bbl. of oil in 24 hours, working under a line pressure of 700 to 900 lb. per square inch. The mean speed of flow is thus a little less than three miles an hour.

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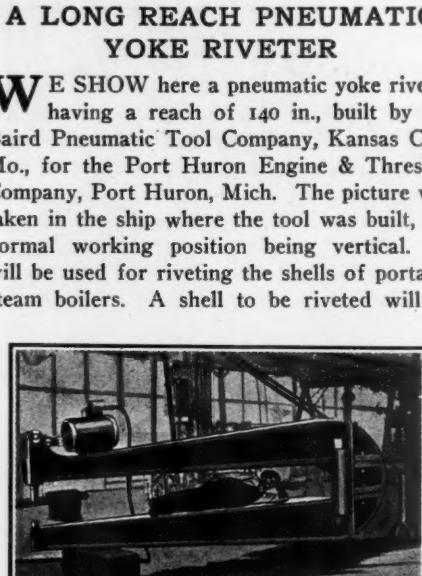
At an airplane exhibition near Vienna a pretty young woman who witnessed how Lieut. Weintritt was floating and slowly dropping to the earth in his parachute, was seized by the frightful idea that this man must surely starve to the death in case he did not succeed in reaching the earth, especially as she did not observe any sensible drop. She started to scream and no argument of bystanders could convince her that the man in the air would not die of hunger owing to his incapability of coming down. At last one man told her that in case the aviator could not descend, someone would shoot holes into the parachute and this would surely bring him down. This argument convinced her and smilingly she went away.

## A LONG REACH PNEUMATIC YOKE RIVETER

WE SHOW here a pneumatic yoke riveter having a reach of 140 in., built by the Baird Pneumatic Tool Company, Kansas City, Mo., for the Port Huron Engine & Thresher Company, Port Huron, Mich. The picture was taken in the ship where the tool was built, the normal working position being vertical. It will be used for riveting the shells of portable steam boilers. A shell to be riveted will be suspended over the tool by a crane and raised and lowered as required, so that it will be possible to rivet the entire shell including one head at a single handling. The total weight of the machine is 17,000 pounds. It will drive rivets up to ¾ in. diameter, exerting pressures up to 140,000 pounds on the rivet dies.



*A Long Reach Bull Riveter.*

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The total annual rainfall upon all the land of the globe amounts to 29,347 cu.mi., according to a recent statement by the U. S. Geological Survey. Of this quantity, 6,524 cu.mi. drain off through rivers to the sea. A cubic mile of river water weighs about 4,205,650,000 tons and carries in solution an average of about 420,000 tons of foreign matter. In all, approximately 2,735,000,000 tons of solid matter are thus carried annually to the ocean.

## PRESERVING JAMES WATT'S OLD WORKSHOP

George Tangye, founder of Tangyes, Ltd., who died recently, resided at Heathfield Hall, about three miles from Birmingham, and for many years the residence of James Watt. The inventor of the steam engine had a workshop in an upper story where he was accustomed to spend a great deal of his time, and which was left and sacredly preserved by Mr. Tangye exactly as it was when Watt died with the various tools lying just as he left them. The Watt Centenary Committee has decided to include among its objects the preservation of the relics of the hall as a national memorial. This garret workshop has been untouched for over 100 years; it is proposed to take such steps as will preserve it for the nation, and an appeal is made for financial support to secure this object. The headquarters of the committee is the Chamber of Commerce, New Street, Birmingham, Eng.

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## A PNEUMATIC WOOD PLANER

THE AIR driven wood planer here shown is designed principally for heavy construction work where large sections of wood are to be shaped or formed, thus taking the place of the adze for many such operations. It comprises essentially an air turbine supported on ball bearings and housed in a frame of aluminum. On the turbine shaft and rotating with it is a propeller-shaped two-bladed cutter, each blade having a cutting edge. To the frame of the tool is attached an adjustable shoe by which the depth of the cut is regulated. The air control is in the right-hand handle as the tool is here shown. An operative air pressure of 100 lb. gage is desirable and the air consumption is 90 to 100 cu. ft. of free air per min. The maximum speed is 12,000 revs. per mim. The planer is manufactured by the Turbine Air Tool Company, Cleveland, Ohio.

*Air Planer for Shaping Timbers.*

© Underwood & Underwood.

# The "Vindictive," Salvaged By Air, Given To Belgium

## Glorious old Hulk, which Blocked Harbor of Ostend to German Submarines, Lifted from her Grave by Use of Huge Cylinders of Compressed Atmosphere, to be a Naval Shrine of King Albert's People

NOT UNTIL nearly two years after the Armistice and the close of the Great War, was the glorious old hulk of the *Vindictive*, sunk across the channel entrance to Ostend, Belgium, blocking it to the submarines of the Germans, removed from the path of navigation. By a delicate salvaging operation employing compressed air, the *Vindictive* was raised, after a year of preparation, on August 15 and 16, last, at a time when the tide was the highest of the summer season. The Editor of COMPRESSED AIR MAGAZINE was one of the many visitors present, and witnessed the operation.

On Armistice Day, Nov. 11, 1920, while the majestic and impressive ceremonies were being held for the Unknown Warrior in Westminster Abbey, London, and a similar ceremony was proceeding at Paris for an Unknown Poilu of France, the wreck of the *Vindictive* was formally presented to Belgium by Commodore Young, D. S. O., who had superintended her raising for the Salvage Department of the British Admiralty. Commodore Young, of the Liverpool Salvage Company, was one of the active heads of the Admiralty's salvage department during the war, it will be remembered.

In replying to a tribute of the Burgomaster of Brussels, Commodore Young said that the volunteers who had blocked the harbor with the vessel at midnight on the night of May 9, 1918, had accomplished an unparalleled feat. M. Pierard, Director-General of Marine, in accepting the gift, said that during the war, Belgians were always gazing seaward for the coming of the British Fleet that was to bring salvation.

On the occasion of the raising of the *Vindictive*, a considerable crowd of people assembled to watch the work, for Ostend, Belgium's most famous seaside resort was filled with visitors from all parts of the world. The crowd was of course on shore, but the operations were also watched from a distance by the Admiralty yacht *Enchantress*, which was lying in the harbor. On board the yacht was Admiral Lord Beatty, First Sea Lord, with naval representatives of friendly powers.

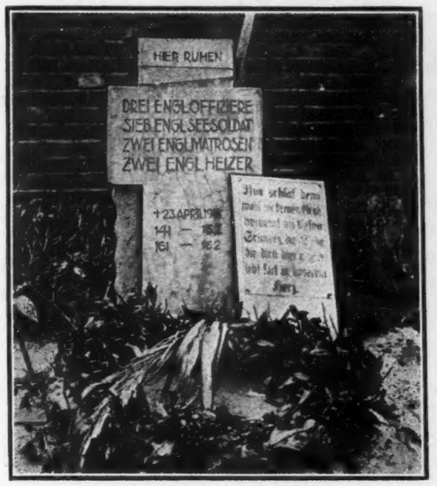
The famous hulk represented a weight of 6,500 tons. Two lighters on one side of the *Vindictive*, and one on the other, held massive steel cables, which had been passed under the hull by divers. At nine o'clock the tide began to rise, and the lighters, rising with the water, strained more and more at the cables, two huge cylinders of compressed air aiding in the operations. These tanks were filled by air compressors just before the craft began to rise, the water being blown out. This of course gave the submerged tanks, which were fastened to the vessel with slings, their lifting power.

Two vessels were specially employed to pull the *Vindictive* toward the Leopold Lock by means of steel hawsers. The witnesses of the Belgian Government, including M. Anseele, Minister of Public Works, and other spectators watched the progress of events with tense interest. About one o'clock, a slight movement of the hulk was observed, and it rose three feet and then stopped. In another hour, when the water was highest, the vessel had risen another eight or nine feet, but could be forced no higher, and the ebb of the tide caused a suspension of operations until the next day.

Over night the cables were able successfully to support the *Vindictive* at low tide, although there was anxiety that they might part. On the next day the weather was favorable again, the tide served, and the work was completed and the historic craft no longer obstructed the entry to the port. Compressed air had once more played its part in salvaging operations; this time in a celebrated and sentimental instance.

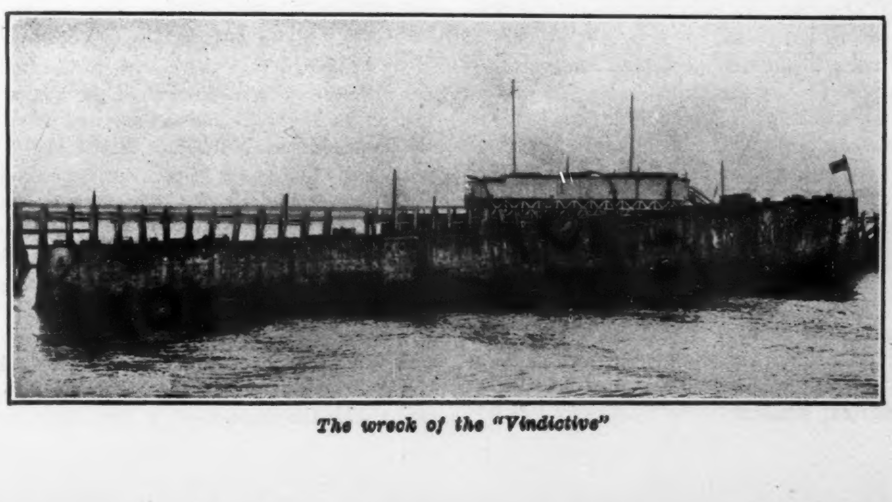
How the *Vindictive* and her gallant crew of volunteers and officers performed their dashing exploit is a naval narrative of the war too frequently told to require retelling in any great detail. In an earlier simultaneous attack upon Ostend and Zeebrugge, the channel entrance to the latter harbor had not been effectually closed, so a new expedition was organized, under command, as before, of Commodore Hubert Lynes. Vice Admiral Sir Roger Keyes was also present himself, in the destroyer *Warwick*. The flotilla was this time on a larger scale, and the block-ship, which was entrusted to Commander Godsal, formerly of the *Brilliant*, was none other than the *Vindictive*, which was to double her glory by a triumphant death.

It was a thick night, real sea fog having drifted in to mingle with the smoke screen that had been laid down, and the *Vindictive* nearly missed her mark, despite two motorboats escorting her with huge Dover flares. By a happy chance, a breeze cleared the fog for a moment, and the *Vindictive* discovered the Ostend piers dead ahead of her. Acting Lieutenant Guy Cockburn, in one of the motorboats, also saw the piers and dashed in under heavy fire, laying his flare right in the channel. The *Vindictive*, without a moment's hesitation, went straight over the flare and into the goal.



*The tomb of the heroes of the "Vindictive"*

The enemy blazed at her with everything they had, according to the official account. A shell hit the after-control and killed Sub-Lieutenant Angus MacLachlan with all of his men. Machine gun bullets made the chart room and bridges untenable, and Commander Godsal took his officers into the conning tower. There, after steaming about 200 yards along between the piers, he left them, and went outside, calling back to them to order the ship to be laid bow on to the eastern pier and so swung across the channel. The order was no sooner given them than a shell struck the conning tower full. It killed Commander Godsal outside and stunned Lieutenant Sir John Alleyne, who was inside with Lieutenant V. A. C. Crutchley. The latter shouted through the observation slit to the Commander, but of course got no reply, so he coolly went on with the swinging of the ship by ringing full speed astern with the port


*The wreck of the "Vindictive"*

engine. When she ceased to move he gave the order to abandon ship and sink her.

The main charges were then blown by Engineer-Lieut. Commander William Bury and the auxiliary charges by Lieutenant Crutchley himself. The old *Vindictive* heaved, sank about six feet, and settled on the bottom at an angle of 45 degrees across the channel. Her work was done. Ostend remained, like Zeebrugge, a complete British victory.

It was a great privilege, for one knowing the history of her great exploit, which will live in the annals of the sea, to see the famous old hulk raised. The Belgian Government will no doubt cherish her and preserve her as a sort of naval shrine, because of the gallant deed performed with her by intrepid English officers and men at a time when Ostend was an important base for the submarine operations of the Germans. F. J. T.

## CLIMATES TO ORDER

"We deliver climates" is the novel claim of W. L. Fleisher & Co., New York, in a circular calling attention to their work in air conditioning. Any air conditions in the world, it is declared, can be duplicated and maintained in factories, such as a cool climate with low humidity for chocolate manufacturing, a warm


*An Assorted Climate Load.*

climate with high humidity for bread dough, a cold climate with high humidity for cold storage and a warm climate with low humidity for photograhpic materials. Several typical illustrations are shown for the purposes just mentioned.

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Remarkable properties are claimed for a new Bavarian porcelain. A special glaze expands and contracts in exactly the same degree as the mass of porcelain, and chemical and other vessels made from the material not only endure great heat, but are not fractured by sudden changes of temperature. It is even possible to fuse holes in the new porcelain, using an oxy-hydrogen or oxy-acetylene blow-pipe, without causing cracking. The material, moreover, can be worked like glass, and different pieces can be fused together, or a porcelain tube or handle can be fused to a dish. The blow-pipe-softened mass can be blown like glass into bulbs or other forms not hitherto produced with material of this kind.

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Taking the country as a whole, the Geological survey states, crude oil has replaced coal as fuel by considerably less than one percent. of the normal demand.

## STEAM IN COMPRESSOR WATER JACKET

Under the title, *Prevented Steam in Compressor Water Jacket,* there appeared a communication in *Power* of November 16, which we reproduce together with a reply from Frank Richards, Associate Editor of COMPRESSED AIR MAGAZINE, both of which will doubtless be of interest to many of our readers. We first print Mr. Sharp's observations:

"A well-known type of cross-compound air compressor was sent out from the factory with a ¼-in. pet-cock screwed into the highest part of the water jacket on the low-pressure cylinder for releasing the steam that might accumulate at this point. It was found that in practice this cock was seldom opened, and to obviate this non-automatic feature, it was removed and enough ¼-in. pipe and fittings used to run this discharge to the funnel that catches the cooling water coming from the cylinder. A small part of the cooling water is discharged from this pipe and thus prevents any accumulation of steam."

JOHN T. SHARP.

Canton, Miss.

Mr. Richard's reply, offering suggestions, was published under the title, *Preventing Steam in Compressor Water Jacket,* as follows:

"John T. Sharp, on page 796 of the Nov. 16 issue, calls attention to a trouble he had with an air compressor. Although he corrected it in a common-sense way, it might be proper to offer a supplementary explanatory remark.

"It will be remembered that at the highest point of the water jacket of his compressor there was a ¼-in. pet cock that was intended to be opened occasionally to release steam, and as the opening was neglected, the pet cock was removed and an open connection made to the main overflow.

"It does not seem to be best to let the story end there, because as it stands it suggests that the water in the water jacket gets hot, whereas it never gets hot at all. On any modern compressor with normal jacket-water circulation the water at the overflow should not be even blood-warm.

"On the compressor under discussion the water was piped into the head-jacket at one end of the cylinder near the bottom, circulated through the cylinder jacket, and was then discharged from the other head-jacket near the top, flowing into the overflow funnel from the open end of the pipe.

"It happened that there was, at the top of the cylinder, a small portion of the water jacket above the overflow outlet, and here the water would remain more or less stagnant and would at times get quite hot, occasionally reaching the boiler point, and as a means of relief the pet cock was used. The compressors of this type are now sent out by the makers with a little overflow pipe similar to that provided by Mr. Sharp."

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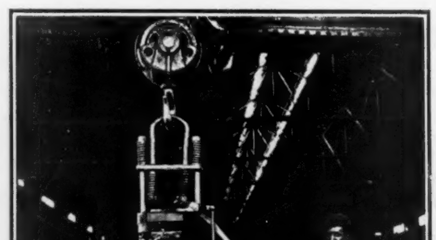
A Congo oil company has recently built a 360 km. (225 mile) pipe line to connect the interior with the coast.

## PNEUMATIC HAMMER FOR BREAKING IRON PIGS

THE SLOSS-SHEFFIELD Steel & Iron Co., Birmingham, Ala., is manufacturing a pneumatic hammer for breaking pigs and sows apart. It is in operation on several furnaces in different plants at present and is being installed on others, and has proved to be a very efficient tool for this kind of work. It will break pig iron at an average rate of one ton per minute into pieces of proper size.

At the plant of the Sloss-Sheffield Steel & Iron Co. this tool is in use on three furnaces and the company is expecting to install it on two more. It is also being installed by the Central Coal & Iron Co. at Holt, Ala. The company sells these hammers only in pairs for the reason that the nature of this work is such that the equipment should be carried in duplicate. Although the breakage has been very light a furnace using this method for breaking pig iron would naturally not have on hand men to handle the iron in case of a breakdown of the tool. It is therefore required to carry the equipment in duplicate.



*Pneumatic hammer for breaking pig iron.*

The superintendent of furnaces for the Sloss-Sheffield Co., Mr. J. P. Dovel, has supplied the following information in regard to the details of this pneumatic machine. The cylinder is eight inches in diameter with a stroke of fourteen inches. The air pressure required is 60 lbs., and the average air consumption per minute amounts to 60-75 cu. ft. The device averages fifteen strokes per minute and the weight of the machine is 2,500 lbs.

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A new acetylene blowpipe has been introduced by the Swiss Carbonic Acid Works, Berne. The difficulty has been that the acetylene producers do not give out the gas at enough pressure to work the bunsens well. In the new blowpipe ("Carba") a small cylinder of liquid carbonic acid is added to the equipment; and a very small quantity of this is sufficient to get up a pressure which produces a long blue and very hot flame of great stability, which it is very easy to regulate.

# The New U. S. Naval Experimental and Research Laboratory

*By HAVELOCK C. HISLOP*

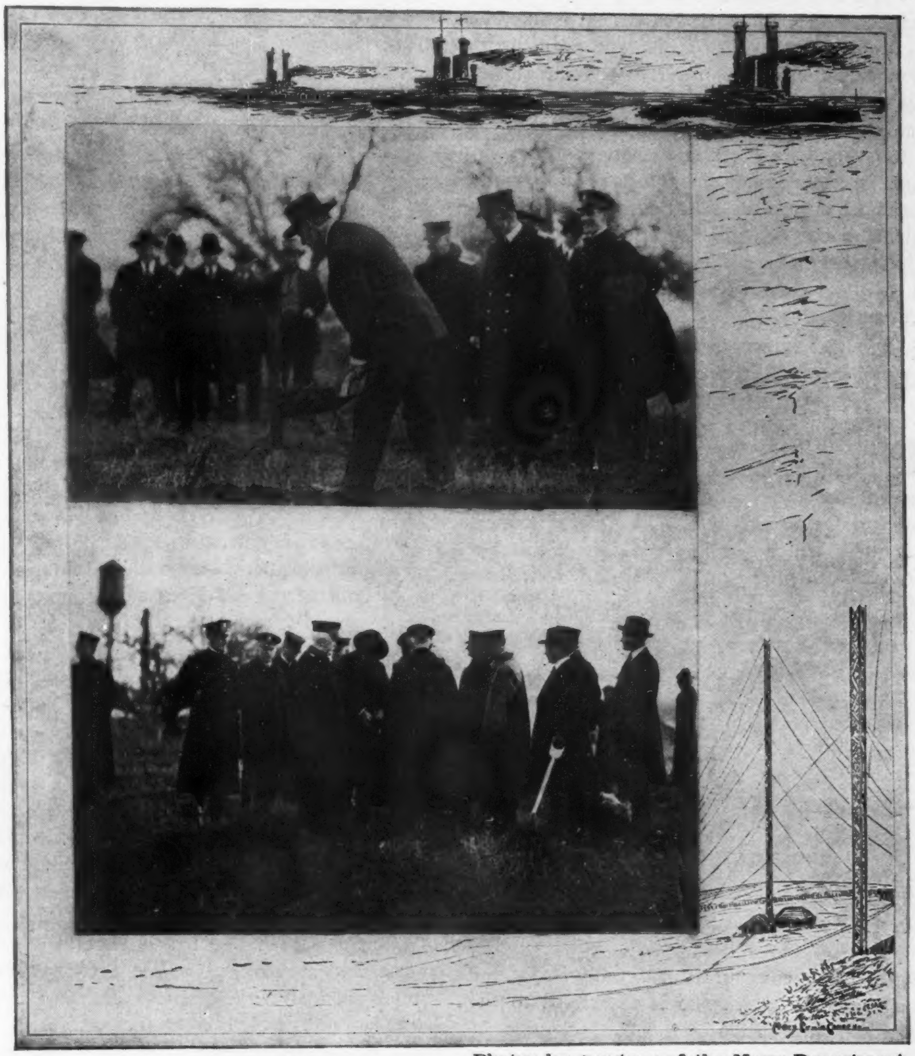
THE American Navy has begun construction of the new experimental and research laboratory at Bellevue, D. C., situated on the Potomac, about four miles down the river from the Washington Navy Yard, an undertaking initiated in the course of the late war by the Naval Consulting Board, of which Thomas A. Edison is president. It was one of the first recommendations of the Naval Consulting Board that this laboratory be established at the earliest opportunity, and the American people are to be congratulated that the project is now taking practical shape.

An appropriation of not to exceed $1,500,000 was obtained from Congress, but Secretary Daniels desired to conserve the capital of the country directly for war purposes, so the work was not begun in the course of the conflict. Various private laboratories, such as that of the General Electric Company, were freely offered and used for naval research work necessary during the war. These laboratories served a most useful purpose because available for immediate use.

The new naval laboratory, when completed, will differ from any other in that civilian scientists and engineers, represented through the Naval Consulting Board, will have an opportunity to engage in research work for the benefit of the navy. In a sense it will be a civilian laboratory for the benefit of the navy. Inventors will be encouraged to submit and to have tried out various devices intended to improve naval equipment and service. The law providing for the laboratory authorizes direction by civilian scientists. It is proposed to select the best-equipped technicists for each problem of sufficient importance and give them every facility and opportunity for experiments.

The service of such men was of the highest value during the war and naval officers feel the need of their help and vision in the future problems of naval advancement, which fact was freely and gratefully acknowledged by Secretary Daniels in his annual report of 1920. He holds that close coöperation between civilian and naval experts is essential to obtain the best results.

For many years the Navy Department has realized the necessity of a well equipped and centralized laboratory, and the plan was well received when a committee of the Naval Consulting Board, headed by Mr. Edison, gave extended thought and practical consideration to the subject. Armed with specifications and plans, the committee appeared before the House Naval Committee in March, 1916, with the result that Congress granted an appropriation for the purpose in the Naval Act of 1916. Before a site could be selected and plans prepared to come within the appropriation allowed, war was declared by the United States, and in view of the urgent necessity for labor and material in war construction, besides financial considerations, the erection of the buildings was postponed.



Photos by courtesy of the Navy Department.

*Mr. Daniels, Secretary of the Navy, is seen in the upper picture breaking ground at Belleville, D. C., on Dec. 6, 1920, for the new U. S. Naval Experimental and Research Laboratory. In the lower view naval officers are to be seen gathered at the site to witness the ceremony.*

The realization of the project has now become possible. The site was selected in February, 1920, as recommended by a conference consisting of Messrs. W. L. Saunders, Frank J. Sprague, and Dr. W. R. Whitney for the Naval Consulting Board and Rear Admirals Griffin, Taylor, Earle and W. S. Smith for the Navy Department. The ground at the Bellevue site is solid and the depth of river water is adequate, the government reservation there embracing nearly 85 acres. The site has many advantageous features. It is owned by the government, so no expenditure for land was necessary. It is in the District of Columbia and becomes a national naval institution; and it is within a short distance of the Navy Department, its files, and its sources of technical information.

When Secretary Daniels turned over the first spadeful of earth on December 6 last, plans and specifications had been completed and the contract awarded for a plant consisting of a three-story laboratory and office building 60x200 feet, a machine shop 82x300 feet, a foundry and forge shop 60x100 feet, a pattern shop and storage building 60x200 feet, and a power plant 70x80 feet. All necessary service installations will be provided, such as gas lines, electric wiring, piping for compressed air, hot and cold water, distilled water and vacuum heat. A special study of successful laboratories at universities and industrial plants has been made, in order that this new undertaking may be, from the first, a model of its class.

The third floor of the laboratory building, it is learned from the Navy Department, has been planned especially for radio experimentation, and walls and roof are to be metallically screened to exclude electrical disturbances. Provision is made for a large assemblage of storage batteries from which current is to be utilized on account of the close voltage control possible by this system.

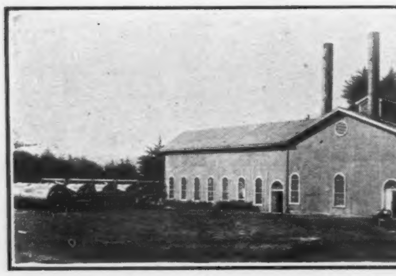
The new buildings are to be of fireproof construction, with reinforced concrete framing and stuccoed terra cotta walls. A sea wall

on the Potomac front and considerable railway trackage are included in the plans, the latter having already been installed. A pier 650 feet long has been built, served by railway sidings, and dredging is in progress to provide berthing space for large vessels. It is intended to moor a battleship of old type permanently alongside the pier in order to provide an actual example of naval construction upon which new devices may be tested.

It is finally interesting to note that a beginning has been made, in consultation with the foremost American scientific and engineering talent, upon a policy of directed research, which, it is believed, will result in great benefit to the navy, and will be for its exclusive betterment.

## CLEANS WATER FILTER WITH COMPRESSED AIR

THE SPRING VALLEY Water Company of California uses compressed air in cleaning out the water filters at the Lake Merced Pumping station. Our illustration shows the filters which are located a short distance from the pumping plant. There are four filter tanks eight feet in diameter and 25 feet in length. The compressed air tank is located along side the tanks, and is connected to the individual filter tanks by a three inch pipe.



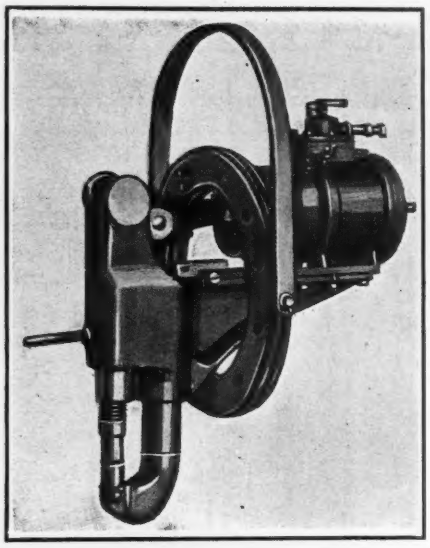
*Exterior Lake Merced pumps showing filters.*

The water pumps force the water through a 4-ft. sand bed, into the collecting pipes below, then on into the main line that leads to San Francisco.

In cleaning out the filters with compressed air, the filter is first cut out of service and the air blown backward up through the sand bed for about five minutes, after which the filter is washed with a combination of air and water. All filters are cleaned in this manner daily.

## SPECIAL PNEUMATIC STAKE RIVETER

OUR ILLUSTRATION shows a special pneumatic stake riveter designed by the Baird Pneumatic Tool Company, Kansas City, Mo., primarily for facilitating the setting of rivets between the firebox flanges connecting the corrugated fireboxes of the outside backhead in Scotch marine boilers. The narrowness of the projecting operative portion is at once noticeable. The machine has a reach of five inches, a gap of twelve inches, with a die adjustment of three inches to accommodate the varying lengths of rivets and thicknesses of plate. The machine is adapted to the setting of one inch steam-tight rivets and consumes 4 cu. ft. of free air per drive of rivets.



*A special pneumatic riveter.*

The air cylinders are tandem unit, having two pistons arranged on a single piston rod, the thrust of which is at right angles to the set of the rivet. The toggles are of single design, being compressed of three pieces directly joined through the connecting rod to the piston rod. Under operation the connecting rod in transmitting the cylinder power to the toggles does not vary more than ½ in. out of a straight line drive.

The machine is suspended from the centre of gravity, being equipped with a circular supporting frame fastened to the rivet stake. Around the periphery of this frame and in a grooved slot, riding on ball bearings is a band fastened to the bail, this providing the machine with a circular working movement and also a swinging movement in either direction. The over all dimensions are 33-in. long and 40-in. high, and the weight is 750 lb.

## ELECTRIC CURRENT CAUSES A BIG FIRE IN A NOVEL WAY

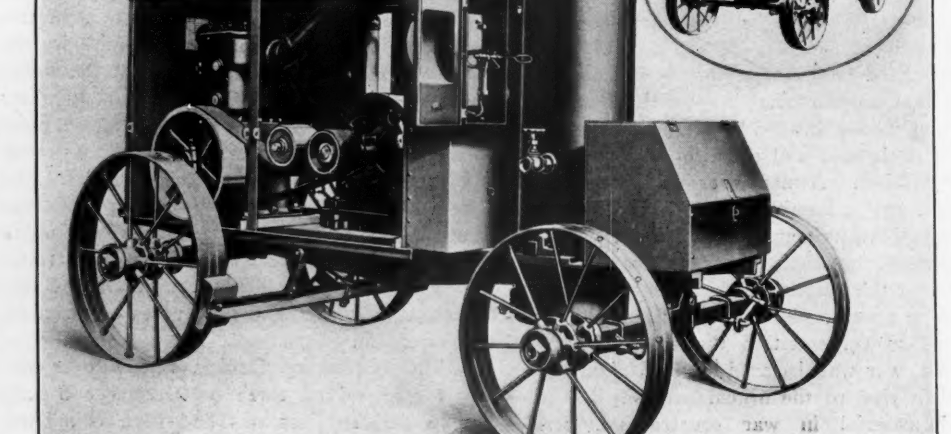
A destructive fire directly traceable to electricity occurred recently at Portland, Oregon. A passing street car trolley came in contact with a guy wire connected with a big furniture warehouse. The current was transferred from the trolley to the wire, thence down a rainspout to roof and vent pipes and forced inside the building; total loss $250,000.

## A NEW PORTABLE COMPRESSOR WITH ELECTRIC DRIVE

CONTRACTORS using compressed air are already familiar with the Ingersoll-Rand gasoline-engine-driven "Imperial" portable compressors. These units are driven by tractor type gasoline motors and built in three sizes, with capacities of 45, 118 and 210 cubic feet per minute.

To meet the ever-increasing needs of the contractors, street railways and public service companies, having available electric current, an electric motor driven "Imperial" has been added to this portable family. This unit is of 118 cubic feet per minute capacity and weighs approximately 4,450 lbs., depending upon the weight of the motor. It is an all-steel outfit from its sheet canopy to the broad tired steel wheels. Light steel doors completely house the entire unit, protecting it from the weather and from irresponsible meddling. These doors are easily removed to allow free access to all parts.

A suitable intake unloader is provided assuring efficient regulation. Either alternating or direct current motor can be furnished. In any case, the motor control is in accordance with standard practice and specifications covering the type of motor used. Additional equipment includes air receiver, safety valve, drain valves, pressure gage and service valves to which air hose lines may be connected.



*No. 12,569 Imperial type fourteen electric driven portable compressor.*

# Compressed Air Helps the Road Builder

By Linwood H. Geyer, M. E.

THE COMING year will witness an unprecedented activity in the building of new roads, and the repairing of existing highways. This programme was started in the latter part of 1919, with the hope that new records would be credited to the year of 1920, but unsettled after-war conditions have prevented the realization of these hopes. In many cases, moneys were not appropriated for the municipal, county and state highway commissions, and in others, where moneys were appropriated, these were too quickly eaten up by high labor and material costs, and under production. Fortunately, prospects for the coming year are brighter, and the programme for various communities indicates record activity.

There are reasons for this increased road building. The war is responsible for limited road building programmes from 1917 until 1920, which has caused the poor, and frequently impassable condition of many of our highways. During these same years our railroads were over-burdened, and "shipping by truck" increased by leaps and bounds. Heavy trucks —most of them equipped with solid tires—pounded over our roads twenty-four hours a day. Many of these highways had not been built to withstand heavy traffic. Neither the road surfaces nor the foundations were built to handle the tonnage which passed over them. Trucks driven at unwarranted speeds during the night, and often inadequately equipped with headlights ruined the shoulders of the roads, and destroyed the all-important drainage provisions. Then too, in truck trains one truck usually follows in the tread of its predecessor, pounding ruts through the surface, and down into the road foundation.

Instant repairs would have helped, but it was not possible to make these within a reasonable length of time after the destruction was apparent; with the result that roads were too quickly made impassable. Of course, when one highway was destroyed, truck trains chose one detour after another, and now all highways between busy centers are frequently in inferior condition.

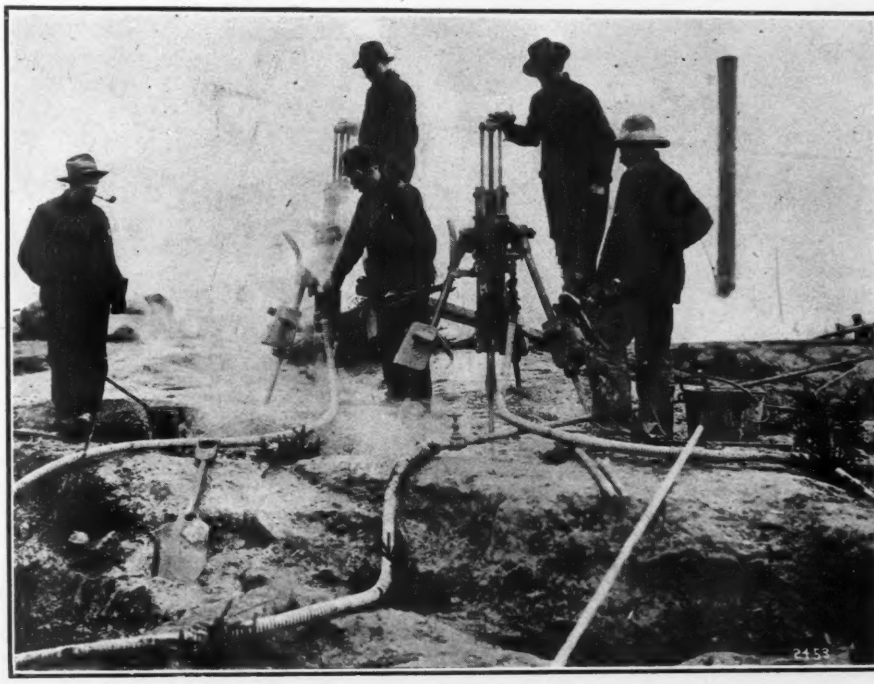
The war was also responsible for the decreased mileage of new highways. For three or four years, we have not maintained the old average, whereas we should be building more miles of new road every season to keep up with the increasing demand for better facilities for truck shipping and pleasure touring.

Not only does the country need more new roads and more repairs, but it needs these just as quickly as possible. The requirements of any one municipality, county, state or privately owned business are so great that every means should be taken to build these roads as cheaply and quickly as possible. This can only be accomplished by using labor-saving machinery. Compressed air has long served the road-builder in many ways, but increased use of this power medium will very materially decrease the cost of road construction and maintenance.

Every road building project that involves the removal of rock calls for the use of machine drills and accessory equipment. Heavy piston type drills mounted on unwieldy tripods and driven by steam were formerly used for all of this work. The introduction of compressed air and the constant improvements in air compressors and drills, resulting in the highly efficient and simple modern machines, have been responsible for the almost universal adoption of air as the power medium.

In most cases the road builders' rock drilling requirements are met by some one size of "Jackhamer" drill. The "Jackhamer" type has won international approval, because these lightweight self-rotating hammer drills require only one man for the setting up and operation of each drill. Machines of this type will put down holes to six, twelve, or 20 feet according to the size and power of the drill, and at the same time will drill holes at any angle and any place that affords a foothold for the drill runner.

"Jackhamers" are now the accepted standard for light work such as the removal of out-



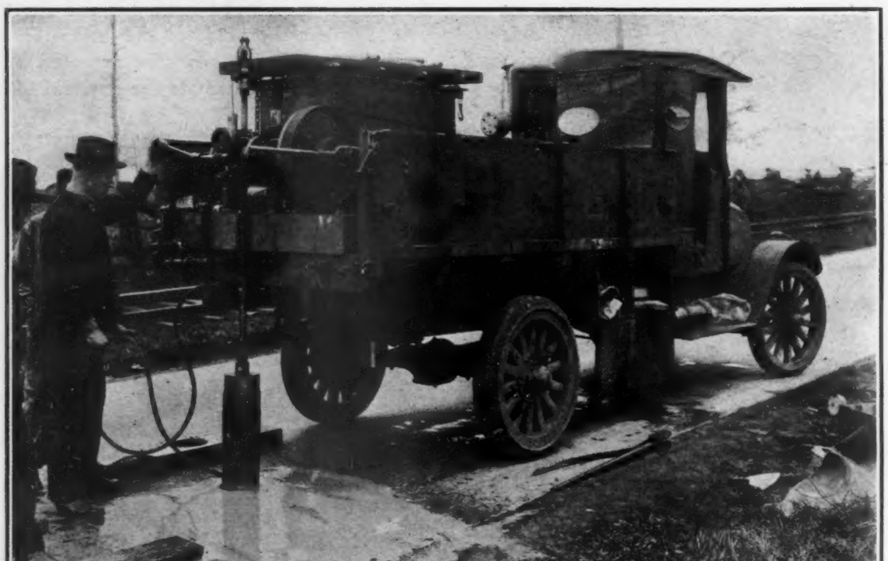
*Light weight drill sharpener used for sharpening steels on road construction.*

*Piston drills on a deep rock cut for an Eastern State road.*

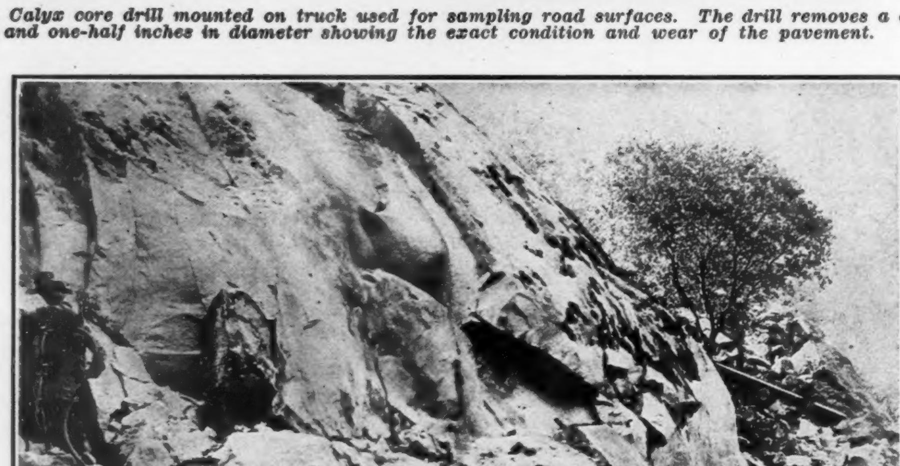
cropping ledges, trench work and grading. In the quarries furnishing the rock used for surfacing and foundations, "Jackhamers" met with almost instant approval. These drills are also used in tunnels, although for this work the larger, mounted type of machines are preferable. The "Jackhamer" has its advantages because a contractor having this type of drill for the regular run of work, can mount it on a tripod or column and drive the occasional tunnel without needing to purchase expensive, heavy drills for a small tunnelling job.

The advantages of "Jackhamers" for ordinary rock work are obvious but an interesting example of their application was recently demonstrated in New York City, in the making of a deep rock cut through altered gneiss, to lower the grade of a crosstown street. Here the contractor first employed three piston drills. Six men drilled an average footage of 70 feet per drill per day. These piston drills were replaced with three heavy "Jackhamers" (70 lbs.) and with these drills only three runners were needed and the average daily footage per drill was increased to 120 feet.

For road building the portable compressor offers the most handy and efficient air supply. The cost in time and labor of setting up, tearing down, and moving a non-portable unit is considerable. To this must be added the cost of extended pipe or air hose lines with their almost unavoidable leakage costs, water pockets and couplings. The portable compressor requires no housing or foundation and, in most cases, no steam boiler equipment.



*Calyx core drill mounted on truck used for sampling road surfaces. The drill removes a core six and one-half inches in diameter showing the exact condition and wear of the pavement.*



*"Jackhamers" removing rock for grade of western mountain highway.*

During the last few years a number of portable compressor plants have been developed, the most popular being those having compressors of the vertical duplex type, gear driven by, or direct connected to, a tractor type of gasoline engine, or belt driven by an electric motor. Such portable plants are usually complete with the compressor, engine or motor, fuel tank (if necessary) and an air receiver, with safety and service valves. The cooling system generally consists of a radiator with fan and circulating water pump, although in some instances a thermo-syphon system replaces the circulating water pump. Manufacturers generally mount the entire plant on a steel frame supported on steel axles, arrangements being made for team, truck or tractor haulage. Gasoline engine driven types are usually preferred by the road builders, because, in many cases, their work does not permit ready access to a supply of electric power, whereas a gasoline fuel supply is usually easy to procure. For city street repairs, involving the removal of asphalt or concrete surface, and where roads are often torn up for pipe trenches and conduits, the electric motor driven type is becoming increasingly popular.

As an alternate to the portable compressor and where only a single drill is to be operated, some contractors employ a small semi-portable outfit. Such a plant usually consists of the compressor, and an engine mounted on wooden or steel skids, the entire outfit being sufficiently light to permit of its being loaded on and off a truck.

Where the volume of rock excavation is such that a large number of drills are to be employed, a stationary air compressor of greater capacity will be needed. The selection of the type of drive—electric or steam—is generally governed by local conditions.

### Sharpening Drill Steels

Second only to the drills and the compressors is the method of bitting and shanking drill steels. Although many contractors use hand blacksmith tools for this work the tendency is toward machine sharpening, following the methods most approved by the mines and quarries. Machine drill sharpeners using compressed air are now developed to a high degree of perfection, and they forge and form bits and shanks of better quality, truer gage, and greater wearing strength than those made by hand. Frequently, when hand sharpened tools are used, the blacksmith finds it difficult to maintain a sufficient supply of sharp steels. This is especially true where hard rock is being drilled, which rapidly dulls the bits. Even where only three or four drills are in use a small sharpener soon pays for itself. Not only will the machine work faster, due to the better bits, but the life of the drill will be lengthened because of the true shanks.

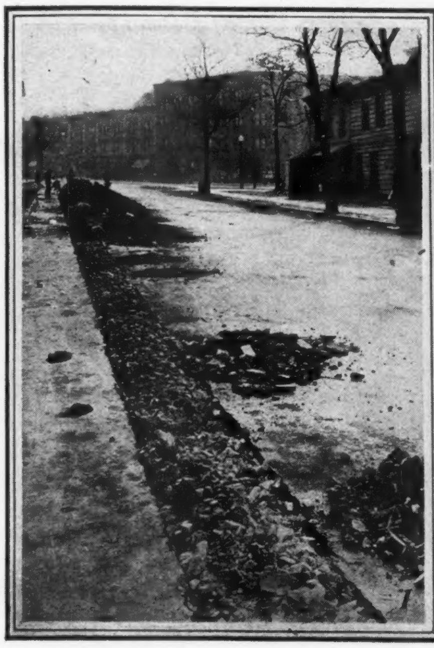



*Fig. 1—Asphalt and underlying duct loosened by CC-25. (No. 13336). Fig. 2—Tie Tampers breaking up concrete for track repairs in New York City. Fig. 3—Drift bolt in repair work on Los Angeles Street Railway.*

There, too, the blacksmith will have time to look after the many odd jobs for which he is always needed.

Another point to be seriously considered is the fact that with modern drill sharpeners it is possible to secure a gage variation of 1/16" between successive steels, whereas with hand methods it is unusual to better a ⅛" variation. This smaller variation very materially decreases the drilling necessary to bottom a hole of a specified diameter. The following comparison offers an excellent example of this:

| | Hand Sharpening. | Machine Sharpening. |
|---|---|---|
| Size drill steel. | ⅞" hollow hexagon. | ⅞" hollow hexagon. |
| Diam. starting bit. | 2¼" | 1⅝" |
| Guage variation. | ¼" | 1/16" |
| Size powder. | 1¼" | 1¼" |
| Depth of holes. | 6' | 6' |
| Blacksmith shifts. | 2 hours. | 1 hour. |
| Blacksmiths. | 2 | 1 |
| Helpers. | 2 | 1 |

Small sharpeners, which are light in weight and easily moved, will generally take care of the hammer drill steel, while for heavier work requiring bits of large diameter it may be preferable to establish a central shop with a larger sharpening machine.

## Trench Excavation and Pipe Laying

Rock excavation in digging trenches for pipes or conduits is a hand hammer drill job. Not only will they do the work faster but each drill can be handled by one man in cramped quarters. Where drainage is necessary available direct-acting pumps may be driven by air, saving the expense of an electric driven centrifugal pump or a steam supply.

After the trench has been dug the portable compressor is frequently used for supplying air to small (2½ to 5 HP) pneumatic hoists. These hoists will easily handle the pipe and, after the pipe has been laid and the joints calked, the same hoist can be used to pull a drag or wheel scraper in backfilling.

## Pavement Cutting

With the many improvements which have been made in pneumatic machinery it is now considered an unnecessary expense to cut asphalt, concrete, or bitulithic pavement with a pick or chisel and sledge. Not only is the hand method laborious and slow, but it is wasteful, in that quite often the opening is larger than is necessary. For asphalt and bitulithic pavement cutting the tool in general use is a pneumatic machine bitted with a sharp bladed chisel. The method employed is, first a marking is made by sliding the chisel along a chalked cutting line; next the chisel is used to cut down and through the paving, and lastly, the same chisel is used to pry up the slab to be removed. Although in many cases a heavy chipping hammer has been used for this work it has been found advisable, where the extent of the work permits, to use machines which are specially adapted for this service. Large public service corporations and city paving contractors are constantly confronted with the removal of road surface, for pipe and conduit trenches and for pavement repairs. A number of these companies are now using a machine known as the "paving breaker." This machine is non-rotating and operates on the same principle as the hammer drill. It can easily be handled by one man. Shanked steels with moil or chiseled bits are used to break up the paving, the steel being held in the machine by a steel retainer.

In cases where such work only occurs at infrequent intervals, contractors, having "Jackhamers" as a part of their regular equipment, remove the rotation elements from these drills and use them with a bull-point steel.

Electric railway companies have long since adapted the pneumatic tie tamper as the most satisfactory way to tamp their track. In many cases road surfaces, which must be maintained by the street railway company, are torn up by using the tie tamper with a chisel bit—although many of these same companies are now standardizing on the "paving breaker" because of the larger quantity of this work which must be done, during all seasons of the year. These same companies often use their tie tamper compressor cars for supplying the air, although electric driven wagon portable compressors, similar to those described above, are frequently used.

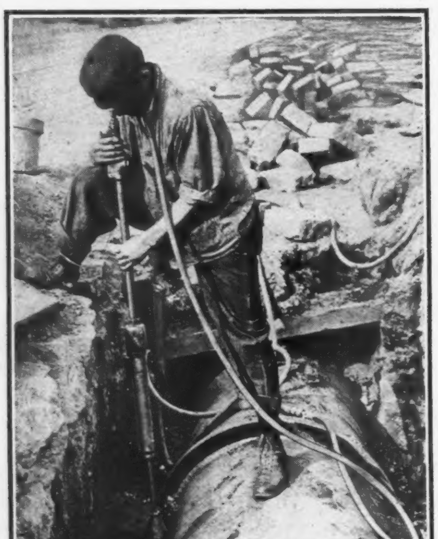
## Testing Pavement

The practice of taking samples from completed roads or streets, making thorough laboratory tests—such as microscopic examinations, accurate measurements of their thickness, abrasion resistance, and the like—is an approved method of inspection and research, but the reliability of the information gathered depends largely upon how the samples are taken. While it is possible to remove such samples with hammer and chisel the process has naught to commend it. A Calyx core drill does better work, in less time and at lower cost. It bores and extracts symmetrical plugs which are most convenient for examination and test. The damage to the pavement is restricted to a very small area and is easily repaired.

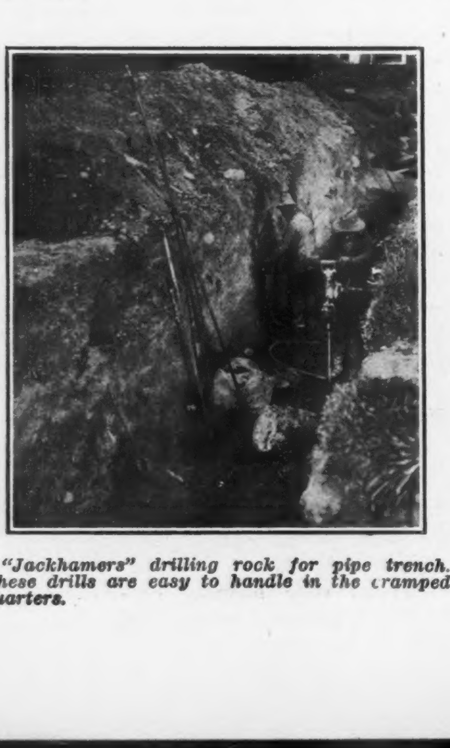
The Calyx outfit is simple, easily manipulated and for convenient transport can be mounted on a wagon or motor truck chassis. Its operating costs are low and but one or two men required.

Several state highway departments have

"Jackhamers" drilling on rock cut in New York City.



Pneumatic rammer tamping backfill around water main.



"Jackhamers" drilling rock for pipe trench. These drills are easy to handle in the cramped quarters.

adopted this method of pavement testing to their satisfaction.

The above uses of compressed air will give some idea of the labor and time saving which can be accomplished by using this medium.

## BOILING POINT LIMITS OF ALTITUDE FLIGHT

THE ACCOMPLISHMENT of actual flight by the heavier-than-air machine was only the stating of a problem rather than the solution of it. The problem as it develops is one of numerous and unusual complications and we are continually hearing of new difficulties encountered and overcome.

For instance, as we learn in *Automotive Engineering,* Major Schroeder experienced unexpected trouble during his altitude flights at McCook Field on account of the failure of his pump to constantly deliver gasoline to the carburetor when reaching high altitudes. Upon the installation of the Schroeder flowmeter in the gasoline feed system, he discovered boiling of the gasoline at altitudes from 6000 ft. up. This was indicated by bubbles appearing in the glass tube of the flowmeter at about 6000 ft., these bubbles increasing in number and size with the altitude, finally resulting in breaking the suction of the pump and consequent failure of the pump itself.

Experiments in the laboratory of the Materials Section, Engineering Division, reproduced this situation exactly on reducing the pressure on the gasoline to pressures corresponding to that of the atmosphere at various altitudes, and an analysis by the distillation process showed the fuel to be casinghead gasoline rather than straight run. As casinghead gasoline has a much lower boiling point than called for by specifications Nos. 3511-B, covering domestic, 3512, export, and 3513-A, fighting gasoline, the conclusion was immediately reached that a fuel having a higher initial boiling point and, consequently, conforming more closely to the specifications, would stop the boiling that had been experienced.

The principal lesson from this series of experiences is that the Air Service personnel erroneously regards a gravity of 65 deg. Baume, or specific gravity of 0.721, as proof of the good quality of the gasoline. As a matter of fact, two gasolines, one straight run and the other blended casinghead, can be given identical specific gravities and still have very different distillation curves. The casinghead gasoline will show considerably greater loss by evaporation before it gets to the carburetor of the plane, and considerably less power delivered in the motor after it gets there, than does the straight run gasoline.

Inspection of specifications Nos. 3511-B, 3512 and 3513-A will disclose the fact that specific gravity is not named as a requirement of either of the three gasolines, but that entire dependence is placed on the distillation curve. Specific gravity is of value only in distinguishing between straight run gasoline of the same base, and is of no value whatever in determining the quality of the gasoline unless it is known beforehand whether the gasoline is from a paraffine or an asphaltum base, and also that it is a straight run gasoline. The distillation curve, on the other hand, is a sound basis for judging the relative values and is the only known, reasonably short test.

## SIXTY BILLION BARRELS OF OIL

THE OIL records of the world present some curious anomalies. The quantities of oil "in sight" in the ground, the relative rates of production and consumption in the several countries and the prospects of continuance of supply show wide discrepancies. For instance: the latest figures compiled by the United States Geological Survey of the Department of the Interior show that the foreign countries are using only half as much petroleum as the United States, but have seven times as much oil in the ground.

These countries are now using about 200,000,000 bbls. of oil yearly, but they have resources large enough to last more than 250 years at this rate of consumption. In striking contrast are the production figures for the United States, which at the present rate of more than 400,000,000 bbls. a year has only an eighteen-year supply. In other words, the United States is using up its own oil supply fourteen times as fast as the rest of the world.

Not counting all to be obtained from shales and other retortable materials by distillation," said the announcement, "the world's supply of recoverable petroleum amounts to as much as 60,000,000,000 bbls. Of this amount 43,000,000,000 bbls. may be regarded as oil more or less definitely 'in sight' as shown by actual drilling with successful results. The remainder covers the available oil which it is believed will be found in other regions in which oil seeps. Asphalt deposits or favorable geological conditions point to oil, although no producing wells have yet been drilled. Of this great amount, which is thirteen times the oil already taken from the ground in America and about nine times all the petroleum yet produced in the world, 7,000,000,000 bbls. only, in round numbers are believed to be left in the United States and Alaska, the remaining $53,000,000,000 being in foreign countries.

"This latter supply is nearly equally divided between the old world and the new, the Americas having a total very close to that of the remaining continents. "Fortunately it is simply impossible to discover and take out the oil remaining in the ground in the United States, 7,000,000,000 bbls., in so short a period as eighteen years."

## SAFETY OF AIR PASSENGERS

In a single year, England's air service carried 70,000 passengers and but one accident occurred in which there was an injury. This is a remarkable record, and proves that passengers are being carried through the air with all danger of accident practically eliminated. Germany has also been making some fine records with her commercial and passenger fliers, and the number of routes being operated daily totals into a considerable number.

# Ways to Overcome Stuck Steel Troubles

**By D. E. Dunn***

EVERY mining district has the most difficult drilling in the world. If you don't believe this, ask the drill runners about the conditions in their district. In the Michigan copper country the amygdaloid is bad and conglomerate is worse. In the Lake Superior iron district the soft hematite is sticky and the cherty iron carbonate wears the bit gage. Butte rock is hard and "fitchery"; Joplin ground is full of "vugs," and the pebbles falling behind the drill bits stick the steel—and so it goes.

One of the principal troubles that cause difficult drilling is stuck steel. Drill steel becomes stuck for the following reasons:

1. Improper alignment of drill steel and hole.
2. Incorrect type of bit.
3. Incorrectly formed bits.
4. Feeding too much or too little water.
5. Weak drill rotative power.
6. Worn or broken shanks.
7. Worn or broken drill parts.
8. Drilling into a seam or in "fitchery" ground.
9. Pebbles falling behind bit or mud collar forming behind bit.

A common cause of stuck steel is the improper alignment of the drill steel with the hole. When this occurs the drill steel will bear on at least two points in the drill hole, there is tendency for the steel to bend, increasing with the divergence from true alignment, and a severe grinding on the reaming surfaces of the bit. All of this will cause difficult rotation and will, in many cases, stop rotation entirely.

This condition is due to poor operating. The steel must be brought nearly into line to have it enter the hole. The experienced drill runner can line up the drill laterally "with his eye." He will do this after entering the steel and cranking it nearly to the cutting face, and tighten his "tee-bolt nut." He will then open the throttle (inlet) valve a little, and let the drill find its own vertical line, helping it a little by raising up on the crank end, and finally tightening the clamp bolt nut. If the hole is very much out of line time can often be saved by abandoning it entirely and starting a new one.

The choice of the proper type of bit is important in helping to eliminate stuck steel. For example, a narrow rapid-cutting chisel bit would bury itself in some soft limestones. Six-point bits are usually in disfavor because of their slow drilling and small clearance space for the cuttings.

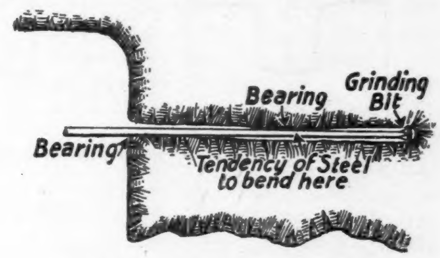
The cutting edge has the greatest diameter on a single taper bit. This cutting edge wears rapidly, and soon the diameter is less than at another point farther back on the bit. Then the hole cut by the cutting edge is too small to admit the rest of the bit and a reaming action takes place which will soon stall the rotation and stick the steel. To overcome this many and varied designs of bits have been made, some of which were extremely complicated, and if they had any advantage underground, the time taken by the blacksmith to make them and resharpen them more than outweighed this advantage.

The bit that has been found most successful for rapid cutting, long-wearing gage, and ease of making and resharpening is the 14 deg. and 5 deg. double-taper cross or four point. This double-taper bit when properly made has a reaming surface whose diameter is the same as the diameter of the cutting edge and which backs up the latter with a good stock of metal, increasing the life of the gage. It also acts as a guiding surface, preventing the steel from running off into seams or fissures. The use of this type will, in the majority of cases, remedy any trouble caused by wear of gage.

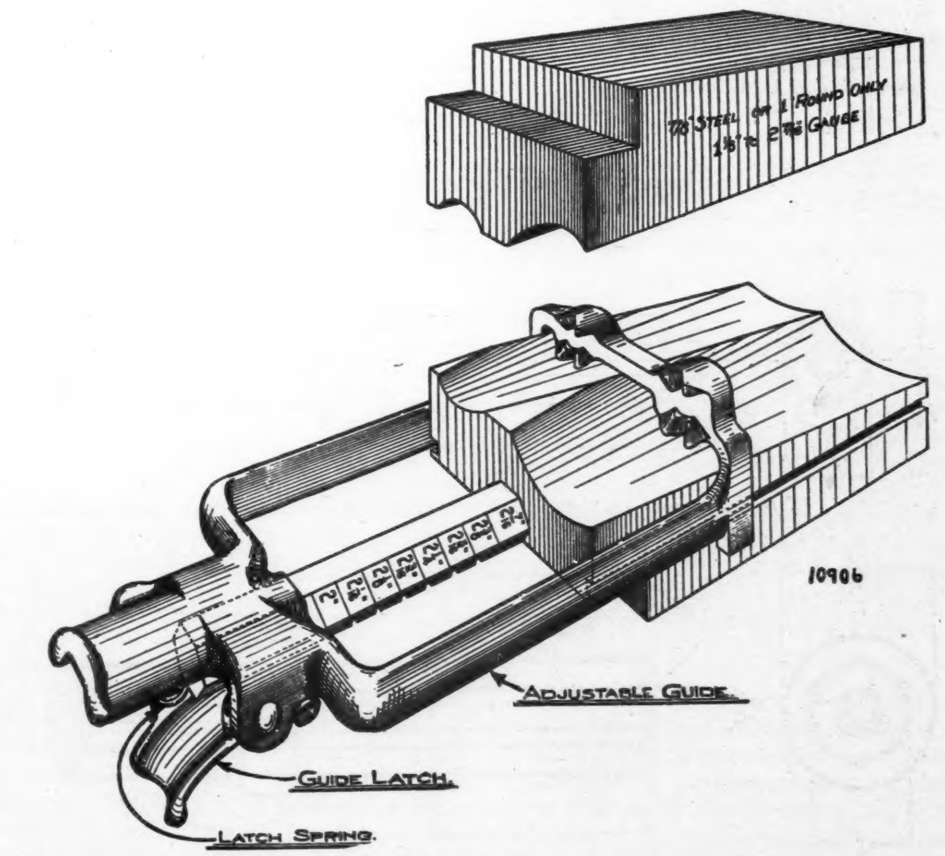
It has already been said that the bit should be properly made. That leads to consideration of the methods of making and sharpening drill steel and their bearing upon stuck steel. Primarily, there are two methods of sharpening drill steel, by hand and by machine. The latter method is by far the more rapid, accurate, and satisfactory, and should be used wherever three or more drills are in operation. However, even machine-made bits are sometimes faulty. This is usually due to careless blacksmithing, because the machines are extremely simple and rugged and, should they get out of adjustment, it is a relatively easy matter to put them into proper condition again.

The manufacturers of drill-steel sharpeners are continually making the machines more nearly fool-proof. One of the latest improvements for assuring better bits is the use of double-bored gaging blocks with an adjustable latch guide. The wide range of these blocks permits the operator to gage accurately an entire normal run of steel on the one set of blocks, and these adjustments for the various gages require only the pressure of a finger on the adjustable latch guide.

An interesting but less common cause of stuck steel is the feeding of too much or too little water through the hollow drill steel. When too little water is fed a mud collar frequently forms behind the drill steel, which makes it difficult to extract the latter. Sometimes when drilling into rock bearing metallic ore, and too much water is fed, a mineral separation takes place. The gangue is sludged off, and the drill pounds away ineffectively on the



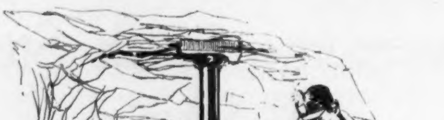

*Steel and hole out of alignment.*



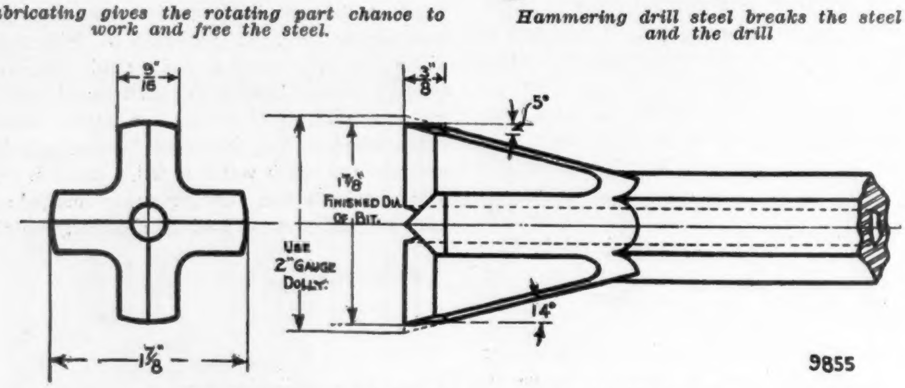

*Double bored gauging blocks used on Leyner sharpeners.*

*Reprinted from Engineering & Mining Journal.

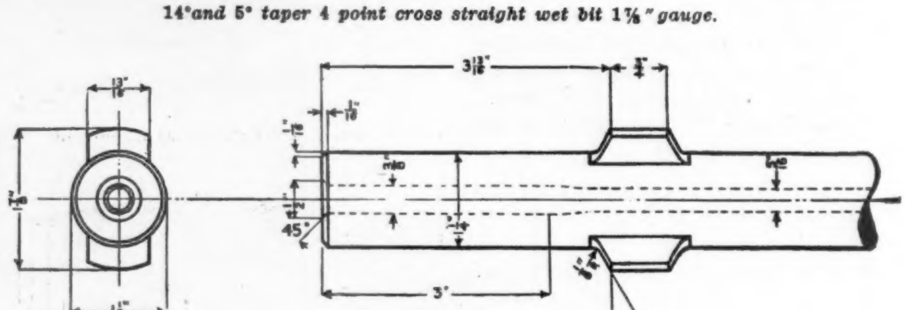
*Lubricating gives the rotating part chance to work and free the steel.*



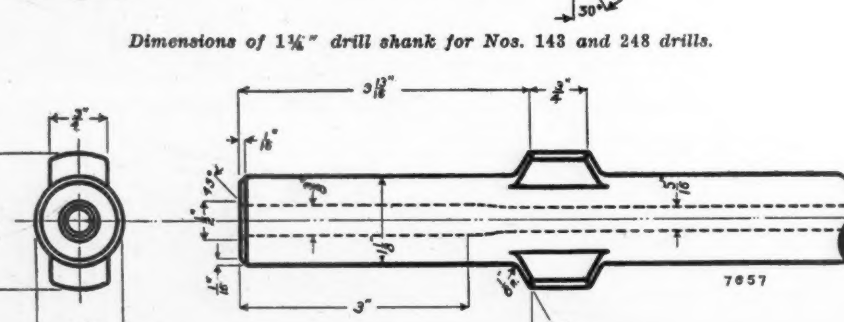
*Hammering drill steel breaks the steel and the drill*



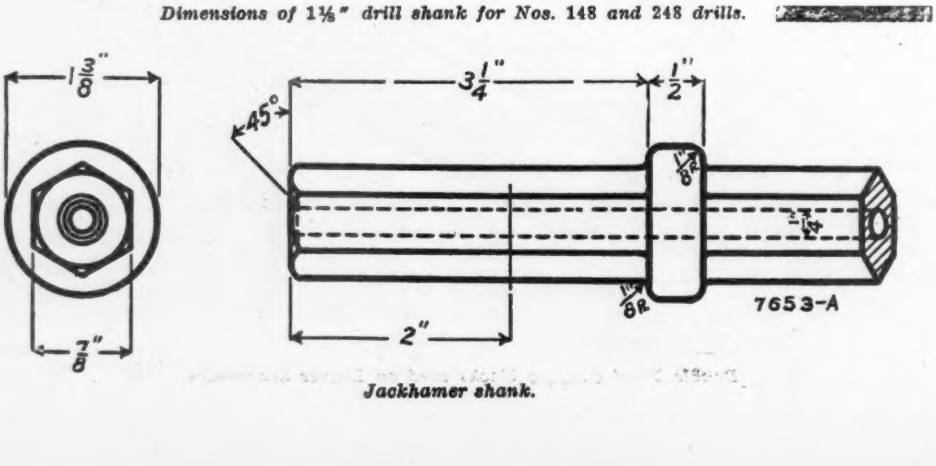

*14° and 5° taper 4 point cross straight wet bit 1⅞" gauge.*




*Dimensions of 1¼" drill shank for Nos. 143 and 248 drills.*




*Dimensions of 1⅛" drill shank for Nos. 148 and 248 drills.*




*Jackhamer shank.*

metallic residue, finally becoming stuck. Some times dry drills are run in abrasive ground The steel soon heats up, and the temper is rapidly burned out of the bit. This condition may be remedied by using a water feed or a wet drill.

Sometimes the shank portion of hexagon steel becomes so worn that it permits the steel to slip in the rotative sleeve, or the lug on round steel becomes worn or broken off, with the same result. The drill steel will then be hammered into the ground without rotating and will soon become stuck. The only remedy for this is to keep the shanks in proper condition. The same results are obtained when use is made of worn or broken drill parts, principally worn pawls, chuck and bushings, and broken pawl springs and rifle bars. The only remedy is to replace the worn or broken parts.

The rotation of some drills may be too weak for the rock conditions. This, however, is exceptional, because rock-drill manufacturers have strengthened the rotative power of the drills up to a practical limit. Frequently, drill trouble is attributed to weak rotation when that is far from being the true cause.

Unequal cutting may easily take place when drilling into a seam or in fitchery ground, and this throws the steel out of line and sticks it. Drilling into brecciated ground sometimes causes pebbles or small bits of rock to fall behind the bit, and these wedge against the steel and the drill hole, stopping rotation. In some limestones and other calcareous formations the water mixing with the cuttings will form a mud collar back of the bit.

In all of these instances mentioned it becomes a question of loosening and removing the stuck steel. There is one popular method of performing this operation that should *not* be followed, and that is to pound away on the drill steel with a 16-lb. double jack. This manner of loosening the steel is common, but usually the only real results obtained by it are bent steel, broken drill parts, strong back, and increased vocabulary. Usually the steel itself stays stuck. However, there is another method of loosening the stuck steel that is practiced effectively in many camps. Here is how it is worked by Bert Chadwick, mine foreman of the Black Hawk Lead & Zinc Co. at Picher, Okla.

Upon employing a new man he shows him his working place, tells him what he wants done, and then retires to the background to wait for the new man to get into trouble. This the new man usually does, as the rocks are very oppressive and small pebbles continually fall behind the drill bits. Usually in a short time the steel will get stuck in the hole, the drill man begins to sweat, pounds the steel with a sledge, and gets no results. About this time Chadwick steps up, saying "Let me try it." He takes the oil can, fills the back and front cylinder oil pockets with oil, opens the throttle, and 99 per cent of the time the steel backs out of the hole without any further trouble. The blow slightly loosens the drill steel and the properly lubricated rotative parts take care of the rest.

Rock-drill lubrication is not given sufficient thought, yet it is one of the most important

items in drill operation. Representatives of the large oil companies and of the large rock-drill manufacturers are waging a continual campaign of education along these lines. Their greatest foes are ignorance, thoughtlessness, and negligence. However, the increased ease of operation and the greater speed of drilling of properly lubricated drills should convince the operator that this matter ought to be properly considered. The increased footage and the decreased cost for drill repair parts should convince the mine manager.

There are proper and improper lubricants for rock drills as for any other machinery. With every drill shipped is sent an "oil tag," which designates the best lubricants for that drill. These tags embody information that has meant exhaustive and costly testing on the part of the drill manufacturers. The information is valuable, and should be recognized as such. However, sad to say, a great number of operators still think that axle grease is good enough, others think cylinder oil will do, and others don't think. Representatives of either oil companies or the rock-drill manufacturers are always pleased to consult with the representatives of the mine management and to give them the benefit of expert knowledge and long and varied experience.

## SUGGESTIONS FOR THE USE OF AIR MACHINERY

*By C. T. BAKER*

Close observation of many compressed air installations will reveal, in many instances, a glaring neglect of good engineering judgment.

It is unfortunate that the idea prevails too generally that no especial care need be exercised in the selection or operation of compressed air machinery and accessories, for it is just as possible to waste energy and incur high maintenance costs in the operation of such equipment as it is with any other class of machinery.

It is a common thing to find air receivers set directly on the ground with no foundation under them and no provision made for draining. Then again, some engineers appear to think that pipe lines used for conveying compressed air need not be erected with any idea of eliminating right angle turns or that such pipe lines require supporting as do steam or water lines. Consequently hay wire is generally used for hangers with the result that the pipe sags and often develops wasteful leaks at the joints.

Seldom in the smaller installations do we find air separators installed on the compressor discharge line between compressor and receiver for removing water and oil from the air and rarely do we find the air cylinder lubricated with air compressor oil such as is developed especially for air compressor lubrication.

In some installations no safety valve has been provided for relieving the air receiver of excessive pressure and often when such valves are installed they are neglected and therefore become unreliable.

To eliminate as far as possible the trouble resulting from the foregoing causes the following suggestions are offered.

All compressors, air receivers and the entire piping system should be properly erected and suitable foundations provided wherever necessary.

Place air separators where necessary and provide automatic traps for draining same.

Equip air receivers with drain traps and reliable safety valves, provide the very best grade of air compressor oil for compressor cylinder lubrication and use it with judgment.

Run all air pipe lines as straight and direct as possible and support properly with suitable hangers well placed.

Inspect and grind in compressor suction and discharge valves at regular intervals for leaky valves mean loss of capacity and waste of power.

Place the air inlet pipe where the least amount of dirt and grit will be likely to enter the cylinders.

An ample supply of compressor jacket cooling water should be provided and the water should be as free as possible from mud and other matter.

Use a good grade of piston rod packing and don't keep the stuffing box glands so tightly adjusted as to cause rod heating and loss of power due to abnormal friction between rod and packing.

If the air cylinders are provided with indicator taps, take cards occasionally which will, if properly interpreted, indicate what the compressor is doing.

If the compressor is equipped with speed or pressure control devices don't treat such devices like a "step child" but give them the attention deserved.

# Personal Intelligence

Representative Marion E. Rhodes has been appointed to the chairmanship of the Committee on Mines and Mining.

* * *

Professor F. W. Sperr of the Michigan College of Mines was made chairman of the recently formed organization of Copper Country Mining Engineers.

* * *

Mr. Henry Hinds, formerly of the U. S. Geological Survey and more recently with the Sinclair Oil Co., is now connected with the Pantoteck Oil Co. of New York City.

* * *

Mr. Arthur H. Carpenter has accepted a position as professor of metallurgy at the Armour Institute of Technology, Chicago, Ill. Mr. Carpenter was for some years with the American Venadium Co., Pittsburgh, and more recently metallurgist with the Colorado Venadium Co., Sawpit, Colorado.

* * *

Mr. Fritz J. Frank, vice president of Iron Age Publishing Co., has been elected president of the company to fill the vacancy caused by the resignation of Mr. William H. Taylor on account of ill health. Mr. Taylor at one time was vice president of the McGraw Publishing Co. and afterward president of the Taylor Publishing Co. of Chicago. Mr. Frank has been with the Iron Age Publishing Co. since 1910 and prior to this was associated with a number of other trade publications including *Colliery Engineer* and *Mining and Scientific Press.*

* * *

Mr. Thomas M. Rector, formerly in charge of the division of food in the Institute of Industrial Research, Washington, D. C., has been appointed to the directorship of the department of industrial chemistry of the Pease Laboratories, Inc., at No. 39, West 38th St., New York City.

* * *

Mr. Wilkinson Stark, late of the U. S. Army Ordnance Department is now connected with the John Johnson Co., Brooklyn, New York, on its engineering staff.

* * *

At a meeting of the Council of Federated American Engineering Societies held recently, Mr. Herbert Hoover was elected president and Mr. William E. Rolfe of St. Louis and Mr. Calvert Townley of New York were chosen as vice-presidents.

* * *

Mr. H. S. Mulliken, of Lexington, Mass., has been appointed metallurgical engineer of the Bureau of Mines, as assistant to Dr. F. G. Cottrell, the Director, in handling special professional work connected with the Bureau.

* * *

Sir E. M. Raeburn, K. B. E., who until recently was the popular representative in New York of the British Ministry of Shipping, has been appointed the General Manager for Scotland of the Canadian Pacific Ocean Services Ltd. His headquarters will be at Glasgow.

* * *

Mr. B. F. Tillson, a member of the American Zinc Institute, acted as president for the Institute at the Tenth Annual Safety Congress held in Milwaukee. Mr. Tillson was appointed to the chairmanship of the Mining section of the convention.

* * *

Mr. F. B. Layton, vice-president of the Bader Coal Co., has organized an independent company under the name of the F. B. Layton Coal Co., with offices in Milk St., Boston, Mass.

Mr. Marcus A. Dow, general safety agent of the New York Central, has brought out a fourth motion picture for use in giving safety lessons to the employees of the road. Unlike "The House That Jack Built" and other films heretofore produced for the New York Central, the present one deals mainly with the startling facts of the railroad accident records of the whole country. The title of this film is "Bulletin 70," and the story is based on the annual statistical accident report of the Interstate Commerce Commission for the calendar year 1918, which was contained in the bulletin of that number.

In a hotel in Detroit recently they were fumigating a room with hydrorganic acid gas, and within an hour after the commencement of the fumigation a man was found dead in the room above. The fumigators of course had little conception of the deadly character of the gas, and considering the careless way in which the operation is often conducted the wonder is that such casualties are not more frequent.

# Technology of Air as a Power Medium

## V. POWER COMPARISONS—Continued

## An Introduction to the Technologic Study of the Production, Transmission, Storing and Uses of Compressed Air as a Power Producing Medium, Giving a Succinct Outline of its Properties and Advantages as Compared with Manual, Steam and Electric Power

By JACQUES S. NEGRU

OF ALL THE characteristics of the air the one which lends itself to the best advantage to enable its use as a power producing medium is its very small cohesion (intermolecular attraction) between the component molecules.

The facility with which the equilibrium volume of a body, i. e. the volume occupied by its molecules and the intermolecular spaces for a given unit weight under normal conditions, changes under the influence of outside factors and the magnitude of the tendency to resume the equilibrium are directly proportional with the body's cohesion. As the cohesion of the air is very small its equilibrium volume can be changed easily by a very small expenditure of outside forces.

The factors affecting the volume equilibrium are heat and pressure. The actions of these factors on the air are respectively: expansion or contraction (according to whether the normal temperature is increased or decreased) and compression or expansion[1] (according to whether the normal pressure is increased or decreased).

The action of the factor heat—physical property expansibility—for the production of air power has been described previously (see COMPRESSED AIR MAGAZINE, October and November, 1920) and it has been stated that the use of hot air power engines is necessarily very limited. The action of the factor pressure—physical property elasticity—on the contrary has proven to be of the greatest industrial value in the production of air power, and to-day when speaking about air power it is quite generally understood to refer to compressed air power.

### Properties of Compressed Air

Compressed air is a well defined product. Its chemical percentage composition by weight is identical to that of normal air (atmospheric pressure at sea level and temperature 60 deg. F.) and its physical properties are relatively the same as those for free air (air at rest at the pressure and temperature of the local atmosphere). Its weight per unit volume and volume per unit weight vary with the pressure according to well determined relations satisfying the characteristic equation of the air

$$\frac{PV}{T} = R = 53.34$$

[1]The English technical dictionary does not have a specific antonymic term for the word compression and uses instead the word expansion. The French can better convey the distinctive effects of temperature and pressure by using in the first case the expressions expansion and its antonym contraction, and in the second case the expressions "compression" and its antonym "detente."

(See COMPRESSED AIR MAGAZINE, May, 1920, p. 9646).

Figs. 23, 24 and 25 show the influence of the variations in pressure on the physical state of the air: Thus:

Fig. 23 indicates diagrammatically the variation of the weight per unit volume assuming the temperature to remain constant at 60 deg. F. when the gage pressure varies for example between 0 and 200 pounds. It can be seen that for these pressures the weight per cubic foot varies between 0.0764 and 1,116 pounds.

Fig. 24 represents the variations of the volume of air per unit weight within the limits of 0 and 200 pounds gage pressure. It can be seen that these variations of volume with the variations in pressure are different according to whether during the compression the temperature of the air is maintained constant at say 60 deg. F. (curve I) or whether the temperature is allowed to raise during the compression (curve II). This is explained by the fact that when air is compressed heat is necessarily developed and if this heat is not entirely removed the temperature of the resultant compressed air being higher than the normal temperature the relation between volume and temperature for a given pressure will naturally hold good. (See COMPRESSED AIR MAGAZINE, October, 1920, p. 9834).

Fig. 25 illustrates clearly the relatively enormous raise of the temperature of the air with the increase in gage pressure between say 0 and 200 pounds.

One of the hardest problems encountered in the efficient production as well as in the use of compressed air is to regulate easily the rise or fall in temperature which necessarily follows compression or expansion. This point will be taken up more fully when dealing with compressed air generators and motors.

It can be seen from these figures that compressed air may be considered to be practically a perfect elastic fluid, i. e. having a quite negligible cohesion, and that a relatively very small outside force is sufficient to produce a very appreciable change in its physical status.

Compressed air fills absolutely the entire space of the enclosing vessel and the pressure it exerts on each and every particle of the walls of the enclosing vessel is identically the same.

These are the basic properties which are applied industrially for the production, transmission, storing and use of compressed air.[2]

[2]When the pressure per unit area is smaller than the normal atmospheric pressure we have rarefied air commonly referred to as vacuum. The industrial applications of vacuum will be considered in a subsequent article.

### Compressed Air Power vs. Manual Steam and Electric Power

The rapid growth of the industrial developments during the last few decades is intimately related to the developments in the applications of compressed air.

Animal power, steam power and electric power—to mention only the kinds of power most widely used—have their more or less efficient applications; but in the struggle between man and nature to overcome local conditions and to speed up quantitative production compressed air power is to be considered as man's most appropriate and useful agent where all other known types of power fail or are inefficient to the extent to render them practically useless.

Animal power, at its very best, is always expensive, of very limited efficiency and appropriate only to where local biological conditions do not interfere to over a well defined degree with the relative physical welfare of the working animal (man or beast).

Steam power, as it is well known, is wonderfully adapted to do relatively efficient work, but as steam is a product resulting from a change of state of a liquid to a gaseous vapor by heating, the universal tendency towards natural equilibrium, i. e. the vapor tending to resume the liquid state, limits its applications only to where this change of state may be maintained economically. This is the reason why so many precautions have to be taken to maintain the steam temperature to above a well

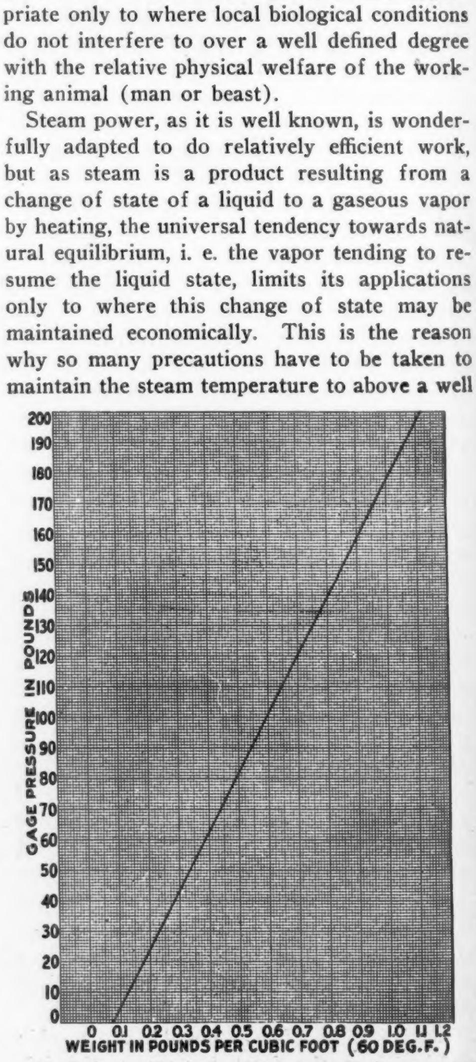



*Fig. 23—Relation between pressure and weight per cubic foot of air at 60 degrees F.*

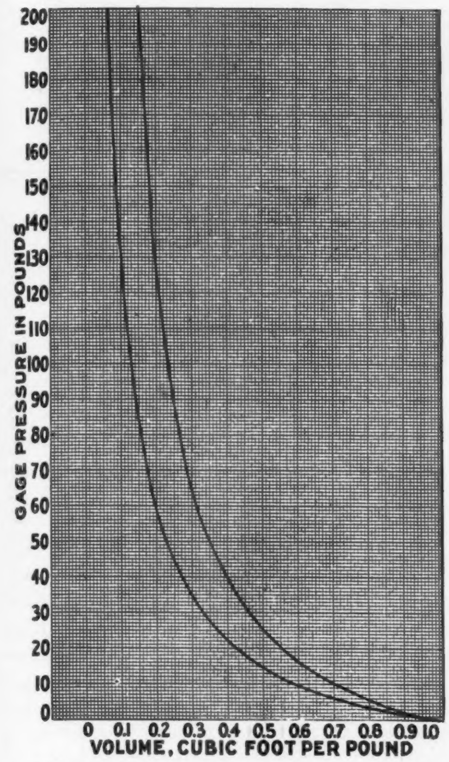



*Fig. 24—Relation between pressure and volume in cubic ft. per pound of air. Curve I refers to the case when the temperature remains constant during compression (60 deg. F.) Curve II refers to the case when the temperature varies with the pressure.*

defined point, thus limiting the length of the steam transmission lines, a fact which requires that the steam power generators and the steam power motors shall be located within very narrow space limits, usually not over a few hundred feet apart, unless exhorbitant steam pipe heat insulating arrangements are employed. Besides, steam as a power producing medium has to be used as fast as it is generated because it cannot be stored.

Electric power is an ideal agent whenever it can be used, but its very nature renders it unfit to a great many applications such as for mining in flammable atmospheres, pneumatic transmission, etc. It also shares with the steam power the great inconvenience of having to be used as fast as it is generated, because up to the present it has been quite practically impossible to store electric power on an industrial scale. The use of storage batteries is costly and still surrounded by a great number of serious inconveniences which restrict their use to within very narrow limits.

Compressed air power can be used in practically all the cases where the above types of power could be employed, and, in addition it is the only known power agent which is appropriate to special lines of work where the others would be quite useless. Thus, taking the mining industry, which is the mother industry, as an example, only a fraction of its progress would have been realized in a given time within the period of the last few decades if the elastic property of the ever present air would not have been put to practical use for the production of the highly flexible agent (compressed air) which did the work in places and with a speed where other power agencies would have certainly failed, or, at the very best proved only of very limited use. Similarly, the recent rapid growth of the chemical industries is intimately related with the growing applications of compressed air for the handling of liquid chemicals and in other phases of operations in chemical plants.

## Advantages of Compressed Air Power

The very wide range of applications of compressed air is made possible by the factor that it is the only other power agent besides electric power which can be transmitted to very great distances from the point where it is generated at a relatively low cost and with quite insignificant loss of internal energy. But the compressed air power has the very great advantage over the electric power in that it can be easily stored and kept for practically indefinite periods in appropriate containers and used intermittently whenever wanted.

It is also noteworthy that the use of compressed air presents the great hygienic advantage that after it has performed the full work it can do the exhaust is the best air renovator, and this is indispensable especially in hot insalubrious working places.

These advantages have contributed to the daily increase in its diversified industrial applications, and no present day modern power plant, or any kind of power using plant, of any significant magnitude would be in complete efficient working order without the adjunct of a more or less elaborate installation for compressed air power.

The potential expectations for further developments of industrial uses of compressed air are highly encouraging. It is certain, indeed, that the time is not far off when compressed air will be *manufactured* on a big scale, stored in air holders and distributed as an every day commodity by pipe lines to consumers in a way similar to that of illuminating or fuel gas. The storing of compressed air in tanks to be shipped to wherever needed can be realized now when the metallurgical and mechanical progresses have practically solved the problem of the manufacture of metal containers to withstand safely the highest pressures produced.

This is bound to be realized first in localities where are segregated small diversified industries requiring limited amounts of compressed air and then gradually become a matter of fact compressed air power manufacturing industry.

Compressed air power still has to some extent the disadvantages of high initial cost and relatively low efficiency; but in the end these disadvantages are amply compensated by its advantages. Besides, judging from the great strides realized within the short period of a few decades in the building of compressed air generators and motors and by the relatively better understanding of compressed air technology, it is to be expected that the above disadvantages will be reduced to a minimum.

## Compressed Air As a By-Product of Superpower Central Stations

The question of the installation of superpower central stations is now broadly agitated and is considered to be the best solution to increase the fuel efficiency and thus alleviate the hardships of fuel shortage. There is no doubt that such installations would somewhat improve the actual low returns we get from the coal consumed; but as long as the power generated will be electric power only the solution of the fuel efficiency problem is bound to be limited to but a small partial improvement, because the demand for electric power varies continuously, electric power cannot be stored industrially to any appreciable extent, and peak loads with low loads always spell high total inefficiency.

The logical solution for an actual fuel efficiency in a superpower central station is the adjunct of a compressed air manufacturing plant which shall equalize the power output of the station during a 24 hour per day run of the plant by using the available power during the low load periods for the production and storing of compressed air. This would then constitute a quite inexpensive byproduct the demand for which is ever growing.

Air compressed to even over 20,000 pounds per square inch is now realized industrially with relative ease and satisfactory efficiency, and its storage and handling does not present the hardships one might surmise when considering the very high pressures involved.[3]

## Uses of Compressed Air

The potential power of compressed air can be used industrially in two distinct manners:

In the first compressed air acts as a static agent, as exemplified by its use for subaqueous work, shaft sinking through quicksand strata, lifting liquids, etc.

In the second compressed air acts as a dynamic agent and is used in a way similar to that of steam.

The applications of compressed air as a static agent imply pressures commensurate with the pressures man can withstand for more or less long periods, and in general relatively small pressures, whereas when used as a dynamic agent the pressure is limited merely to that which is the most appropriate for the apparatus used as motors for the work in view

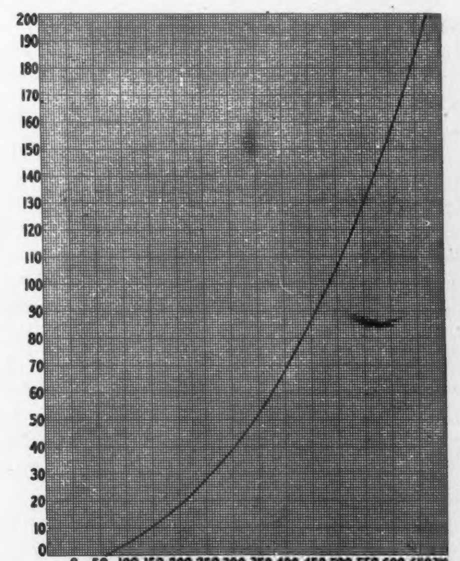



*Fig. 25—Relation between pressure and temperature of air.*

[3]The rapidly growing industrial production, storing, hauling and uses of liquid air is sufficient proof of the ease with which high pressures can be realized and manipulated industrially.

and may even reach thousands of pounds per square inch.

### Main Divisions in Compressed Air Technology

The main points to be considered in the study of compressed air power technology are:

1—The production of compressed air by the most simple, economic and appropriate process. Due attention is to be given to the means to free the air used of its moisture and solid impurities which have such a great influence on the efficient operation of compressed air generators.

2—Transmission of compressed air to any distance from the generator with the least possible loss in internal energy and in the most economic way. Due technical attention is also to be given to the problems of storing compressed air.

3—Means to have the compressed air restitute in actual work the greatest fraction possible of the total work which was required for its production, i. e. use of the most appropriate motors and the most efficient operating conditions for the work in view.

[The next article in this series will deal with the production of compressed air.—Ed.]

## Notes of Industry

### In Europe

The French Government has officially announced that there will be no State monopoly and no interference in the oil industry of that country. Measures will be taken, however, to safeguard the oil supplies of France.

Representatives of the French Government stationed in Japan have made a report to Paris of a method whereby iron may be smelted from volcanic iron oxide sand, which has hitherto been regarded as wholly refractory. The method, according to the French report, has been discovered by scientific experimenters working for the Japanese War Department. It is said that while the discovery cannot yet be employed commercially, the cost of the iron so obtained being too high to compete with iron smelted from ore, the value to Japan of the process from a military standpoint is great inasmuch as it may place that country in an independent position as far as its supply of steel for military and naval uses. Japan, like every other volcanic country, is rich in deposits of iron oxides. The process is being guarded as a military secret but it is said that compressed air is to play a part in making the iron oxides available for treatment. An official statement by the Japanese War Department which the French representatives in Tokio have forwarded to Paris, says:

"Iron sand is so general throughout the entire length and breadth of the Empire that it has long been plain that if some method were discovered of smelting the iron from it Japan would never suffer from want of steel. On the strength of this, the necessary investigations were started by a special committee, with experimental offices established in the Aomori Prefecture and with Dr. Kishi as chief engineer. The experiments of a year have now been crowned with tolerable success, and the process has been experimented with on a practical scale at the Penchihu works, under the control of the Okura firm, with very satisfactory results."

French publications are calling attention to the discovery of rich gold reefs in the neighborhood of Mount Kenya, in East Africa, and are coupling this with the fact that in the Seyidie Province of the Kenya Protectorate valuable deposits of silver, lead, copper and baryta have been found. This is territory that before the war was under the rule of the Germans and it is now being administered by the British. Immediately after the British had occupied the country her authorities took over the mica properties in the Uluguru Mountains of the Morogoro district, for the product was one that was then urgently required by the British Ministry of Munitions. It was an industry confined entirely to that district, where however, it has attained promising proportions. In the two years for which returns were last available the exports advanced from 98 tons to 154. Time and again there have been small rushes for precious stones, mostly in the thickly populated Tanga area, but on each occasion the extravagant hopes were ill-founded. The latest reports indicate that there are in various parts of this territory deposits of different minerals, but the prospecting that has been done up to the present has been a mere scratching of the top soil. South African interests are now apparently devoting much more thought to the possibilities of remunerative employment for capital in that part of East Central Africa and the expectation is that interesting developments may be expected in the near future.

Preparations are being made to exploit the great deposits of lignite, in the province of Murcia, Spain. These deposits were discovered a few years ago in the districts of Mula, Alhama, Totana and Pliego. Some of the strata are more than a metre in thickness. If the investigations yield the results hoped for this "brown coal" will be used for the production of high-tension electricity for the use of the whole Murcia mining district, which is rather short of power. For the time being this is the only use to which the lignite can be put owing to the lack of means of communication.

The Altos Hornos de Vizcaya and the Sociedad Bascona, both of Bilbao, Spain, have installed aero-pulverizors for use with pulverized coal. It is anticipated that a considerable economy will be effected by this means.

### In America

During the first half of 1920, according to commerce reports, 502,667 short tons of pig iron were produced in Canada.

Snow is the latest agency to be employed by officials in solving Salt Lake's smoke problem, according to H. W. Clark, of the United States Bureau of Mines, who is assisting in the smoke probe. Particles of dust in circulation are precipitated with snow, and consequently, the atmosphere is freed from impurities.

Work has begun by the Interstate Commerce Commission in coöperation with the American Railway Association, on regulations to govern the installation of automatic control devices which will stop a train whether or not the signal calling for a stop is seen by the engineer.

According to a communication from the American Chamber of Commerce in Mexico there is a movement under way by which to increase the interest in trade between Mexico and the United States. It is stated that more than 100 American houses have begun business in Mexico the last two years, and besides this, American manufacturers and merchants, as well as chambers of commerce and associations, are making inquiry concerning the Mexican credit. The Americans in Mexico feel greatly encouraged.

The Lakewood Engineering Co. of Cleveland, Ohio, has issued a circular showing the latest addition to the Lakewood line of tiering-lifting electric trucks. The lifting range has been increased to 96 in. and a new model truck embodying double lifting speed has been designed for users handling light bulky packages. This model, No. 703-A, has 2000 lb. lifting and load carrying capacity.

It is reported that Francisco Villa, the former revolutionist and bandit, has discovered rich silver and ore upon the land granted him by the government as part of the amnesty terms. Assays of the ore give fabulous returns in silver values. This land is situated in the district of the Guanacevi mining territory where some of the richest silver mines in Mexico are located.

Negotiations are said to be under way for the operation of a transatlantic air service in the summer of 1922. New York to London would be the eastward trip and Lisbon to New York the westward trip, in order to take advantage of prevailing winds. It is asserted that crossings would be feasible 300 days in the year and that the average time would be 50 hours one way.

The reason assigned for a surplus of coal in France this winter is not the volume of supply but the closing down of factories and other consuming plants.

It may not be generally known that there are gold mines in Transylvania. The working of these deposits was taken in hand by the Rumanians at the conclusion of peace and the quantity extracted under the new regime is just over 300 kilogrammes of refined gold.

The number of cars turned out during the month of October at the Ford plant fell short of 100,000 by the small margin of 33. On October 26, 4688 cars were built, a rate of one car every 18¾ seconds.

# Book Reviews

COMPRESSED AIR PLANT, The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service, by ROBERT PEELE, Mining Engineer and Professor of Mining in the school of Mines, Columbia University, New York. Fourth Edition, revised and enlarged. Profusely illustrated. Price, $4.50. New York: Messrs. John Wiley & Sons, Inc. London: Messrs. Chapman & Hall, Limited.

PREVIOUS EDITIONS of Professor Peele's valuable work are so well known to the mining industry and so familiar to engineers in all lines of industry that make large use of compressed air that it is scarcely necessary to review it, excepting to note the changes and additions incidental to its fourth issuance. It is of course one of the indispensable books on the engineering specialty of compressed air.

Professor Peele is an American authority of note on his subject, and as an educator he ranks high in the mining field. He calls attention in his preface to the 1920 edition of *Compressed Air Plant* that a new chapter has been added (Chapter XXVII) on "Measurement of Air Consumption," which contains data on the flow of air through orifices and short tubes, and a discussion of different appliances for measuring air at both low and high pressure, including simple tank apparatus that can be readily improvised. This addition in itself makes the book worth the price to the interested reader.

A note has been appended to Chapter XXV, relative to some important air lift work, recently done at a large mine in Mexico. The results of this work, which was still in progress as the edition went to press, are declared by the author to throw much light on the problems of raising water by air-lift under heavy heads, and to show the adaptability of the method to unwatering deep mines.

The author has also corrected previous typographical errata in his work. *F. J. T.*

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LIQUID AIR AND THE LIQUEFACTION OF GASES, by T. O'CONOR SLOANE, PH.D. Third edition, revised and much enlarged, with complete illustrations. Price $3; 394 pp. New York: Messrs. Norman W. Henley Publishing Co.

THIS IS a practical work giving the entire history of the liquefaction of gases from the earliest achievements to the present day including, the biographies of distinguished investigators, the manipulation of liquid air and liquefied gases, the modern uses of liquefaction processes and of their products, the utilization of the nitrogen and oxygen of the air, the rare gases, helium, argon and neon, and their utilization.

In the preface to this edition we are told that over twenty years have elapsed since air was liquefied on a large or manufacturing scale. Liquid air was handled in ordinary containers, dippers, tumblers or barrels just like water, and with far less precaution than is exacted by the acids of commerce. As it inevitably evaporated and if confined would develop an enormous pressure, the vessels employed to contain it were necessarily open.

The story of liquid air and of the liquefaction of other gases reads like a fairy tale, but the world has become so satiated with miracles of science that it has almost forgotten how to wonder.

This is a comprehensive volume of reference for all who are interested in this subject and undoubtedly will prove to be most satisfactory to anyone wanting a complete manual of the processes of production of liquid air or its important uses.

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INDUSTRIAL OIL ENGINEERING, a reference book of data tables, general oil information, engineering and industrial oil information for the use of oil engineers, lubricating engineers, oil salesmen, oil equipment manufacturers, mechanical engineers and others interested in the selection, purchase and efficient utilization of oil products and equipment; includes the Lubricating Engineers' Handbook, Enlarged and Revised by JOHN ROME BATTLE, B. Sc. in M. E.; M. E.; Associate Member, American Society Mechanical Engineers; Associate Editor, National Petroleum News; Chief Engineer, J. R. Battle Co. Published in two volumes, Vol. I, now ready. 1131 pp. Price, $10, plus postage. Philadelphia: Messrs. J. B. Lippincott Co.

THIS VOLUME, a notable contribution to the subject, covers the field of lubricating engineering, fundamental mechanical and electrical engineering, industrial oils and processes, fatty oils (their characteristics and uses), lubricating and industrial oil equipment, marketing data for oil, specifications, etc.

Volume I is divided into sections according to the broad classification of the subjects covered.

There are features of this handbook that will appeal to all marketers of oil products, oil company salesmanagers, progressive oil and oil equipment salesmen, oil jobbers, refinery superintendents and compounding plant superintendents, and others who appreciate that the modern buyer of oil products and equipment measures the value of his purchase by the results obtained and demands a service to assist him in the utilization of these materials. The attention of oil salesmanagers is especially called to the adaptability of the book to the requirements of a combined price book and reference recommendation guide to his own brands.

The special features of volume one that will appeal to the mechanical engineer, purchasing agent, machinery designer, bearing manufacturer, are:

The selection and purchase of oil products and equipment is broadly covered, thus assisting intelligent utilization and purchasing of these materials. Much of the latest oil equipment is described and illustrated, thus providing a condensed reference book of all types of this equipment. Many terms and trade customs of the oil industry are explained, thus placing those who are not connected with the industry in a more favorable position to deal with problems that arise.

The fact that oil enters into a great majority of industrial operations makes it imperative, that with the present world's shortage of petroleum and consequent high prices, the latest information upon the efficient utilization of these products should be available to everyone. This handbook offers many valuable suggestions, which will be of great assistance in effecting economies in the efficient operation of industrial equipment and in the reduction of oil wastage.

The book is bound in flexible covers, making it capable of withstanding rough usage. Its size is such that it can be slipped into a salesman's case or travelling bag. The pages are 7½ x5½ inches and are printed in clear type on thin paper. The index is very thorough and an additional aid to quick reference is a thumb index to the main sections.

The book will make an excellent outline for either home study or for oil company schools, for training representatives in the broad field of lubricating and industrial oil engineering.

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ANTIQUE TECHNICS, by HERMAN DIELS. Second enlarged edition, 1920, 243 pages, richly illustrated. Leipzig and Berlin: Messrs. B. G. Teubner.

UNDER MODERN culture we include that culture which is based on technics built up on natural science and the use of natural, including human, energies. Led by this assumption, we trace the roots in the classical periods of antiquity. No doubt this precious branch of historical investigation is fostered best by the combined exertions of technical men and archaeologists. As one of the latest successes of such literary work we have the book of Hermann Diels, member of the Berlin Academy of Sciences. At first he treats very vividly "Science and Technics with the Old Greeks."

He asserts, "Whenever scientific investigation remains united with actual life there is great progress of culture. Technics cannot dispense with science, and vice versa, pure speculation in science if not again and again touched by the fresh breath of life becomes sterile, and decays."

In connection with this pragmatical confession, Diels cites Vitruv, who lived at a time when the scientific sense began to die. Vitruv says: "The architects who without science only looked for mechanical skill have never succeeded in acquiring important influence by their works. On the other hand, those architects who solely relied upon figures and science seem to have hunted for the shade and not for reality.

Only those who, thoroughly combining theory and practice, have the full armour effectually to reach the goal they have set themselves. The scientist Diels, who calls upon Vitruv as witness, is not afraid to polemise against Plato, adducing that this eminent philosopher was no friend of mechanics, since they overshadowed the importance of mathematics, leading from the unsubstantial back to the substantial, and requiring for this most uncommon skill.

In other parts of his book Diels treats on quite concrete matters, such as antique doors, locks, steam engine, automata, antique telegraphy, antique artillery, antique chemistry and antique clocks. These chapters must make an overwhelming impression upon the cultured reader. The technical world owes the author gratitude for the publication. It would be impossible to give more than a short *abrégé* of this work, and it is to be hoped that it will soon be translated into the English language, so that it may find a wider circle of interested readers. *H. B.*

H. L. Kyle, roadmaster at Sacramento, has been appointed engineer of the Western Division of the Western Pacific R. R.

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Correspondence invited from engineers, chemists, experimenters, inventors, contractors and all others interested in the applications, practice and development of compressed air. Correspondents and contributors will please submit questions, or matter for publication, accompanied by self-addressed stamped envelope; they also will please preserve copies of drawings or manuscripts as we cannot guarantee to return unavailable contributions in the event of rejection, though our practice is to exercise diligence in doing so.


## *EDITORIALS*

### FULTON, NAPOLEON AND THE NAVAL LABORATORY

MONSIEUR DE LAVAL, the hero of an historical romance by Sir ARTHUR CONAN DOYLE, was attending a salon of the Empress JOSEPHINE at Pont des Briques, a small village not far from Boulogne. The time was just at the opening of the nineteenth century. Present at the salon were many celebrities of the court, including Marshals of France and generals whose names rung round the world, and NAPOLEON himself.

A small, silent, middle-aged man, who looked unhappy and ill at ease, had been leaning against the wall beside DE LAVAL. Seeing that the visitor was as great a stranger in the company as himself, DE LAVAL addressed some observation to him, to which the guest replied with great good will, but in the most execrable French:

"You don't happen to understand English?" he asked DE LAVAL. "I've never met one living soul in this country who did."

"Oh yes, I understand it very well, for I have lived most of my life over yonder. But surely you are not English, sir. I understood that every Englishman in France was under lock and key since the breach of the treaty of Amiens."

"No, I am not English," he answered. "I am an American. My name is ROBERT FULTON, and I have come to these receptions because it is the only way in which I can keep myself in the memory of the Emperor, who is examining some inventions of mine which will make great changes in naval warfare."

DE LAVAL next soliloquizes:

"Having nothing else to do, I asked this curious American what his inventions might be, and his replies very soon convinced me that I had to do with a madman. He had some idea of making a ship go against the wind and against the current by means of coal or wood, which was to be burned inside of her. There was some other nonsense about floating barrels full of gunpowder which would blow a ship to pieces if she struck against them.

"I listened to him at the time with an indulgent smile, but now looking back from the point of vantage of my old age I can see that not all the warriors and statesmen in that room no, not even the Emperor himself—have had as great an effect upon the history of the world as that silent American who looked so drab and so commonplace among the gold-slashed uniforms and the oriental dresses."

A graceful and an interesting tribute from a gracious and an understanding English writer to a great mechanical genius of the New World. The anecdote was penned 25 years ago, appearing in *Uncle Bernac*, which has vied in popularity with *The Refugees* and *The Exploits of Brigadier Gerard*, from the same distinguished pen.

One wonders whether this tale of ROBERT FULTON, and estimate of him and his influence in the world, was quoted on the occasion of the HUDSON-FULTON Celebration in New York a decade ago. It would have been worth while, even in the midst of all the high tributes paid his name at the time.

The story comes to mind quite naturally in thinking of the possibilities that lie in the new Experimental and Research Laboratory to be erected by the Government for the United States Navy at Bellevue, D. C., described for our readers in this issue by Mr. HISLOP. The new laboratory has as one of its most important purposes the encouragement of civilian inventors.

What epoch-making inventions and new scientific principles, or applications of them, have had to fight their way against the dangers of a little knowledge—break their sensitive wings against the impediments of self-sufficiency and of red-tape.

Engineers and scientists both within and outside the service of the American Navy will welcome the approaching day when the new laboratory is dedicated to its high purpose, and will ever pray that its work be unimpeded by politics or self-interest.

### NAVAL SUPREMACY PASSING TO AMERICA'S FLEET

SHIPYARD owners, naval architects, armament experts and diplomatists in both England and America are following with close interest public utterances in both countries concerning their respective naval armaments and building programmes. America is carrying out her great programme of 1916, irrespective of what other nations are doing. The American viewpoint on its navy is the same now as it always has been—the navy is a peace police force. It is not built nor maintained to constitute an aggressive sea power, but it is kept at high efficiency in case of need.

This American viewpoint usually has been pretty well understood in the British Isles but not so well understood upon the Continent. Some European statesmen can think of might only as a tool to be used to accomplish empirical ends; they do not appear to realize that the United States can support twice its present population of a little more than 100,000,000 people, and that even if aggression were in the American consciousness (which it distinctly is not) there are no economic incentives to such aggressiveness.

England's safety, because of her insular situation, and her world-wide trade and round-the-world colonies and dominions, has always been in her navy, which she maintained as the first naval force among the nations. European quarrels—history's lessons—have taught Britain to be on her guard. The safety of civilization, of free peoples, has often depended upon the English Navy, and the part it played in the late war is too well known everywhere to require discussion. Europe is frequently distrustful of national ideals, and it is hard for Continental peoples to understand American idealism, since they are often prone to class Americans as a race of dollar-getters.

EDITH WHARTON, who has been generally credited with a rather sound knowledge of the characteristics and temperament of our friends the French, tells for instance, how a Parisian

journalist visited America before the war and got this dollar idea. He had the French gift of consecutive reasoning, so when he laid down the principle that every American's ruling passion was money-making, he looked about for a concrete example, and found a striking one. In writing on the subject he said:

"So dominant is this passion, that in cultivated and intellectual Boston—the Athens of America—which possesses a beautiful cemetery in its peaceful park-like suburbs, the millionaire money-makers, unwilling to abandon the quarter in which their most active hours have been spent, have created for themselves a burying ground in the center of the business district, on which they can look down from their lofty office windows till they are laid there to rest in the familiar noise and bustle that they love."

It was artful of the Frenchman to hit upon Boston for his illustration, because he might have selected Pittsburgh, or Chicago, or New York, with its Trinity cemetery, right at Wall Street, which might have served. But unfortunately, as EDITH WHARTON indicated, the cemetery for which the Boston millionaire was supposed to have abandoned the green shades of Mount Auburn was the old pre-revolutionary grave-yard of King's Chapel, in which no one has been buried since modern Boston began to exist, and about which a new business district has grown up as it has about similar carefully-guarded relics in all of America's expanding cities, and in many European ones as well.

One must be careful about wrongful first impressions!

Even in England to-day are misinformed persons who are quite convinced that America has bellicose intentions, and they point to the growing navy of the United States as their proof. Other Englishmen know much better and are only interested in keeping Britain's sea power at first rank as a matter of pride and tradition; they have no thought that America will gratuitously attack England, despite alien propagandists.

A leading English naval expert, Mr. ARCHIBALD HURD, discussed in the *Fortnightly Review* lately, the outlook for the British Navy, and he declared that within three years, by 1924, America would have obtained a naval lead over the British fleet. The article was in the nature of a serious warning, in the view of the Chicago *Tribune*, which commented upon it, that Great Britain must "wake up immediately" if she wishes to retain the supremacy of the sea and desires not to sink to the status of a second rate naval power like France or Italy.

At the same time Mr. HURD commented upon the enormous cost of sea supremacy, with modern battleships costing from £7,000,000 to £8,000,000 each against an average cost of about £1,000,000 twenty years ago.

"Now that peace is signed there remain only three navies of importance, the British, American and Japanese," says the article. "Disregarding vessels projected, but assuming only that those now under actual construction will be completed within the next four years, the standing of these powers in capital ships will be as follows:

"Great Britain, 36 vessels, tonnage 883,290; America, 35 vessels, tonnage 1,150,650; Japan, seventeen vessels, 497,950.

"By 1923, or latest, 1924, the British fleet will have ceased to occupy with pride the place which it has held for over 300 years. The trident will have passed into the hands of the American people.

"No battleship nor battle cruiser is under construction in this country. Three or four vessels, sisters of the *Hood*, under construction at the time of the armistice, promptly were scrapped by the Admiralty and, in the meantime, it not only abandoned these capital ships and 608 other vessels then under construction, but either scrapped, sold or placed on the ineffective list a large number of ships which had been rendered obsolete or obsolescent.

"There are, consequently, no new men-of-war on hand in this country. The result is that year by year the strength of the British fleet with relation to the fleet of the United States must steadily decline, since no heavily gunned nor adequately protected capital ship has been laid down on this side of the Atlantic during the last six years.

"The United States by 1924 will possess twenty-one battleships of the first class, in contrast to fourteen under the British flag and six battle cruisers to our four."

Mr. HURD then examines the arming of these ships and finds that while the American guns will be heavier, longer and will fire larger projectiles, the British guns will be superior in accuracy and this, he says, may counter-balance this fact. This, he points out, will not be enough, however, to balance the immense superiority in numbers of ships and tonnage.

"Naval conditions now rapidly coming into view are calculated to deal a blow to the prestige of the British people and Japan will, if it pursues its considered plans possess a battle fleet at least comparable with and all things considered, probably superior to the British fleet.

"It may be argued that, after all, ships constitute only one element in sea power. We pride ourselves on possessing the sea instinct and we place high confidence in the efficiency of the officers and men in the British Navy. The Great War has shown that this confidence was well justified.

"But the Americans have no reason to blush for the officers and men who composed the crews of their battleships, destroyers and auxiliary craft which took part in naval operations in European waters."

Mr. HURD next asks whether Great Britain will surrender her sea supremacy or fight to retain it at enormous cost. He quotes Admiral BEATTY's warning in a rectorial address at Edinburgh University that history shows no instance of sea supremacy once yielded being regained.

Japan has shown a certain sensitiveness to the American naval programme, both at Geneva and in the published utterances of her statesmen at Tokio. These expressions are not so intelligible possibly to the lay public as they are to diplomatic minds. At the opening conference of the League of Nations a Japanese representative, according to a press attribution, declared his country could not reduce its naval armament programme unless a power not yet in the counsels of the League, meaning the United States, reduced its building programme. A few weeks later a dispatch from Tokio published in London newspapers stated that Baron SAKAMOTO advocated a renewal of the Anglo-Japanese alliance, but with insistence upon the deletion of the clause which exempted Great Britain from supporting Japan in case of trouble with America.

The publication of this significant expression was followed by a statement from an official of the British Foreign Office who said that if any such demand were formally presented to Great Britain that his country would decline to renew the alliance. Thereupon a London newspaper declared that Great Britain was not perturbed over the American naval programme, but secretly welcomed it as "an asset in the coming struggle between the East and the West, in which she is sure to be on the side of Amreica."

Whatever degree of adequacy the American Navy may ultimately reach as an armed force commensurate with safety requirements and in keeping with America's status in world affairs, it is hoped that jingo alarmists in both Asia and Europe may be brought to understand that the United States has embarked upon no armament race, has no thoughts of belligerency, and expects its navy only to preserve peace. America wants no top-heavy, useless armaments, and naval construction will doubtless fall off and expenditures doubtlessly will be cut heavily when such a course becomes the part of prudence. Meantime the American Navy will be a world bulwark.

## AN EDITORIAL ON THRIFT BY CHARLES M. SCHWAB

AT A RECENT dinner of the Pennsylvania Society, Mr. CHARLES M. SCHWAB delivered in the form of a speech an excellent editorial on the subject of thrift in business, in the course of which he took occasion to disagree with pessimists and declared that American business today was merely "getting relieved of impurities." We have thought so well of his ideas on economy of public and private expenditure as a factor in prosperity that we have adapted his expressions in the subjoined paragraphs for the benefit of our readers.

Business in the United States ever since the war started had been, until very recently, upon a false basis. The disposition of many manufacturers had been to say not: "Let me see your costs sheet," but "Let me see your statement of profits."

Now the true test of success in business is not profits but economy. Profits may be the result of good fortune, of a fleeting period of inflation, of temporary conditions of any kind, but a business structure which is built simply upon the profit sheet of the moment is built upon the sands. The only business foundations which are sure and steady are erected upon the rock of economy.

The supreme virtue of the existing situation is that it is compelling every business man in America, in fact, every individual in America,

to examine thoroughly his costs of doing business and his costs of living. The result of it all is to force business and to force individuals to start to economize and to save.

The great need of the world today is to work hard and save. This applies not alone to the laboring man, but to the man of great means. There is no place in America today for the loafer.

The laboring man is entitled to his full share for the contribution he makes to the value of an article. The laboring man should be taken into the fullest confidence of his employers. He should be so sure of getting his fair share of the wealth he produces that he will work with zeal and enthusiasm. Not merely increased production, but increased efficiency in production, is essential.

Economy in Government expenditures is also of vital importance. We should expect and demand the same degree of efficiency in the conduct of our Government as we require in private business. Reckless expenditure by the Government, National, State or city, necessitates higher taxes. These taxes increase prices, and higher prices curtail consumption. The effect of a curtailment of consumption is to increase unemployment.

There is need of immediate revision of our tax laws. While the war lasted we have put up with a make-shift policy, badly conceived and badly executed. Now that the time for real readjustment has come it is the duty of citizens to see to it that taxes are not imposed which encourage extravagance and take from industry the opportunity to invest its earnings. Only by such investments can factories be kept running, and the more factories kept running at full time, the more men will be required to work, the greater will be their output and the higher their wages.

The whole world owes the United States money and the whole world is hungry for the things the United States can supply. Not quite a year ago one of our great financiers returned from Europe and suggested that we create a revolving fund of $500,000,000 to finance the absolute requirements of Europe and start the countries in distress on their way to self-support. Perhaps he did not state the correct sum, but for lack of our ability to sell to Europe through having sufficient credit available, the value of the farm products of this country which Europe would like to buy has decreased during the last few months not hundreds of millions, but billions of dollars.

If the business of the United States is to go forward as it must go forward, our people must take a world view. We must think internationally. We must trust in the good faith and in the productive power of Europe, sending to them our raw materials and goods to enable them to resume productivity, and accepting in payment therefor securities representing their productive activities.

It is a hopeful sign of the time that the farmers and the small manufacturers of the country are beginning to recognize the vital importance of this factor in the situation.

## FRANCE, THE PHOENIX, RISES ABOVE DEVASTATION

ALL WHO ARE familiar with the history of France will recall the speed with which she recovered after her war a half century ago with Prussia. The very latest statistics made available for COMPRESSED AIR MAGAZINE at Paris indicate that history is in this respect repeating itself and that France, after some delay, has struck her stride and is going forward in much the same way as has made the entire world respect and admire Belgium.

Virility and industry is finally being displayed in the work of rebuilding the devastated areas of Northern France. The figures speak for themselves in this matter. Thus:

In 1914 the inhabitants of the area numbered 4,676,400, at the Armistice 1,944,000; on July 1, 1920, there were 3,371,745. Of the 1,195,964 houses existing in 1914 those destroyed numbered 297,777, those needing repairs 277,500. On May 1, 1920, 185,000 had been repaired, 56,700 hutments had been constructed, and 16,800 houses had been built of hard materials.

So, too, it has been with roads, bridges and railroads. Some 52,734 kilometres of roads needed remaking on August 20, of 1920, 23,427 kilometres had been partly restored, 4,294 kilometres had been completely restored, and 1,732 temporary bridges had been erected.

For railroads the figures are: Local lines damaged, 2,385 kilometres; partly restored, 1,675 kilometres; completely restored, 580 kilometres; temporary bridges, 174; permanent bridges, 43. The National railway lines have been fully restored, 2,300 kilometres on one road and 3,300 kilometres on another system.

In industry proper, the figures are surprisingly good. Of 4,096 factories which suffered, 57.9 per cent. had resumed activity (some, of course, on only a small scale) in November, 1919, and 75.8 per cent. on August 1, 1920. In this last month the workmen employed were 42.9 per cent. of those employed in 1914. The metal workers employed in August of 1920, the latest date for which figures are available at this time, were 46.3 per cent. as compared with those of 1914; textiles 22.5 per cent.; wood industry, 35.9. per cent.

These figures apply to France and not to Central Europe, but it has been properly remarked that when one considers that sober, plodding industry is a feature of every great European people one may doubt the pessimists who proclaim that civilization is about to be submerged. In devastated France, at the Armistice there were 1,757,577 hectares of cultivable ground to be restored to use. In the spring of 1920, 877,820 hectares had been sown, and, a little later, 1,159,685 hectares had been ploughed. *B. K. R.*

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An engine built by the Cockerill Society in Liege, Belgium, is claimed to be the most powerful gas engine in the world. It was in process of erection in August, 1914. The Germans after the capture of the city allowed it to be put into operation and when they were assured of its success, took it from its owners and sent it into Germany, to Duisburg, where it was running at the time of the Armistice. It was then sent back to Liege, where it was installed for the second time, with the addition of some improvements. It develops 8,000 horsepower. The cylinders, four in number, are 1.3 m. (51 in.) in diameter, 1.5 m (59 in.) stroke, 94 r. p. m. The heat of the gases coming from the engine is used to generate steam for a turbine.

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The United States possesses 84 per cent. of the world's automobiles, or a total of 7,558,000, according to the latest figures now available. The ratio of automobiles to inhabitants for the leading countries of the world is as follows:

United States, 1 automobile for 14 inhabitants.

Canada, 1 automobile for 21 inhabitants.

New Zealand, 1 automobile for 48 inhabitants.

Argentine Republic, 1 automobile for 113 inhabitants.

England, 1 automobile for 180 inhabitants.

Australia, 1 automobile for 185 inhabitants.

France, 1 automobile for 198 inhabitants.

In the United States, New York State has the largest number of automobiles, or a total of 566,511. Ohio comes second with 511,031, after which comes Pennsylvania, Illinois and California followed by Iowa with 363,079 motor cars.

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A serious accident involving the death or injury of a number of workmen, recently occurred on the River Thames. An oil barge brought in for repairs had been emptied and was understood to be ready for the work. This included the burning out of certain rivets and plates, and it is thought that this work had been commenced by means of an oxy-acetylene flame when the explosion took place, in which seven men lost their lives and others were seriously injured.

The danger of working on tanks which have previously held oil is well known, owing to the gas which is often present, and regulations are in existence with regard to the thorough clearing and steaming out of these tanks which should eliminate the possibility of such a catastrophe occurring, but either they are insufficient for their purposes, or they have not been properly carried out in this instance, or the modifications in oil-barge practice caused by the special conditions existing during the War, have introduced a new element of danger.

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A notable commercial flight has been accomplished by a Handley Page aeroplane. The machine carrying one passenger flew from Berlin to London, a distance of 670 miles, in two non-stop flights in 6 h. 10 min. The first flight was from Berlin to Cologne, 330 miles; the second half of the journey, from Cologne to Cricklewood, 340 miles, was performed in three hours.

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Under the initiative of the Incorporated Silk-Lustring Company, Vienna and Elberfeld, a company has been floated in Czecho-Slovakia with a capital of 40,000,000 kronen for the manufacturing of silk cotton.

# A Present-Day Picture of German Industry

## Food, Raw Materials, Coal and Foreign Credits Required in Increasing Quantities in Order to Place the New Republic in a Position to Help Herself and also to Re-establish the World's General Economic Balance.

By CHARLES A. BRATTER
Foreign Editor, *Vossische Zeitung*, Berlin


HE WHO tries to make a picture of the German economic situation of to-day will not be in a position to make a "still" photograph, but must make a succession of moving pictures. Characteristic of German economics at present is this want of repose. In every direction is movement, at times turbulent movement. German economics has had more to accomplish than the normal transition of the economy of war to that of peace. It has not only to cope with the consequences of an unnatural exhaustion of human beings and property, but in the first place it has had to become accustomed to the fact that the nation has suffered a heavy loss in territory, and a loss of connection and reputation abroad, as a result of the Peace of Versailles.

German reconstructionists have had a hard task, for all these difficulties have come simultaneously, along with a revolution in social ideas. It is sufficient to refer to the troubles and problems in German trade and industry, in order to understand how the first direct results of the war meant a breakdown of the German economic structure. We can only expect a very gradual improvement; we must now be content that there are signs that Germany is on the way to convalescence.

The first and severest crisis which threatened German trade and industry was the collapse of the will and desire to work. It was an international tendency that the demobilized soldier found no pleasure in working. There were two reasons for the no-work attitude having such baleful effects in Germany.

Firstly, because the masses, both civil and military, suffered bodily and mentally from the miserable standard of nourishment, and by the military catastrophe.

Secondly, because the socialist parties, as heirs to the monarchical system, had disappointed the labouring masses, which expected from them a social paradise.

The first social act of the revolution was the bringing in of the eight-hour day, but the political troubles, the mental and bodily exhaustion, as well as the lack of raw materials were responsible for the eight-hour day not being profitably utilized. Not until 1920 was any important progress to be remarked. After the raising of the blockade there came into the land a certain improvement in the conditions of living. In connection with this the political situation became more stable and great strikes less frequent. This reawakening of the desire to work is what permits us to believe in the re-establishment of German trade and industry in the future.

But there is no sphere which in consequence of the retrogression of production has had such difficulties to fight against as the coal branch. No industry was so misused during the war as coal mining. The neglect of railways, and delivering up of engines and cars according to the armistice provoked a crisis in trade, which paralyzed coal mining. The miners had achieved the right to work eight hours a day, but under the bad conditions of living they soon demanded to work only seven or even six hours per day.

At first there were no means of providing lodging for the labourers; therefore it was not possible to send more labourers into the mines to equalize the shortening of the work-day. Thus it is not to be wondered at that coal-mining went back to a tremendous degree. The conditions in brown coaling mining were better, as here work was done during the day, and with the help of pneumatic machines. In spite of this loss of production, Germany was bound to begin with the furnishing of coal to France, to which it was bound by the Peace.

It was natural that the need of coal became a calamity to the whole German industrial and commercial world. The supply of coal to the population was so little, that many families were obliged to freeze in winter, and numerous factories were compelled to close. This brought fresh hindrances to production and created whole armies of workless people.

But we can remark distinct symptoms of improvement since the beginning of 1920. In February the miners declared themselves willing to work over-hours in the interest of production. The result was good, despite the disturbances in the "Ruhr-Revier" in March of this year, after the Kapp-Putsch had reduced the gains. But there are evidences that conditions will soon become better, especially when one considers that in contrast to 1913 we have an increase of about 150,000 miners and about 100,000 brown coal miners.

It is to be expected that a great project for colonization, already begun, will strengthen this most important branch of industry. But the chief thing that must be considered, is, that the miners must be provided with an abundance of victuals, if a permanent improvement in the quality and quantity of work is to be expected.

The most important question, as a matter of fact, in the whole reconstruction problem of Germany, is the matter of a supply of foodstuffs. German agriculture, in consequence of its management during the war, is not in a position to-day to supply all of our population with necessary nourishment. There is not only a lack of appropriate workers, but also a lack of phosphorate fertilizer and a lack of forage. This last was always insufficient in Germany without importation.

The allowance of bread has been greatly reduced; and not even for these small rations have we enough home produce. For fat and meat we are dependent on foreign imports. The amount of German cattle has decreased. To bring it up to its former state will mean years of work, and here enters again the question of forage.

In close connection with the lack of fat is the lack of milk; the children of the large towns cannot be sufficiently supplied with these important necessaries of life. The German economic scheme is dependent on imports also in this line, if a complete collapse is to be avoided in the next few years. These imports of course have increased enormously during the last year. American fat is far more widely distributed in the German towns than German fat. In the shop windows we now see condensed milk, and at least it can be bought by one part of the population. It must be emphasized *one part of the population.*

It is a misfortune that all foreign food-stuffs which come into the country, in consequence of the exchange position of the German mark are enormously dear. With reference to bread, flour and fat, which are distributed by the German authorities, the prices are intentionally kept low by extra allowances made by the state. All other food articles are so expensive that they can only be bought by the very well-to-do part of the population. For the last few weeks the state of the German mark has improved abroad. But an improvement in Germany itself is not to be felt. Just these exorbitant prices for food imports show how important the exchange question is for Germany.

If we were certain that the mark would rise in value, or at least if we knew that it would not fall more, this would have a favourable influence on the prices of imported goods. If German conditions are to become decidedly better, the proportion of imports and exports must be changed. This can be only achieved by an increase in German industrial production. But this is dependent on a plentiful supply of foodstuffs and raw materials; in other words, Germany cannot really recover without the help of the other nations. It is not possible to pay for, with goods, what we receive from abroad in raw materials and foodstuffs for the building up again of German trade, so we can only hope for credit from other countries.

Up to this time, Holland has enormously assisted Germany by a credit-contract. Great

American credits for food are up to this time the hope of the German people. If we lose sight of these great credits, or of the often very doubtful projects of international loans, the private credits of foreign producers play a great part in the German industry. Especially the raw-material producers are able to support the reconstruction of Germany. Next after food, the supply of raw materials is the chief requirement of German industry; important raw materials such as wool, cotton, copper, petroleum and iron, are imported by Germany.

The United States, before the war, was the most important raw-material purveyor, and continues to be so also after the war. Especially, to supply materials for the textile industry, negotiations have taken place between American and German leaders of industry. Thus, for instance, an American society grants to a number of amalgamated Silesian cotton factories the necessary raw materials on credit. As a guarantee to the creditor, the supplied materials remain his property during the whole process of production. A trustee controls the work and one part of the ready-for-sale materials are exported, and in this manner they are the ultimate payment for the supplied raw materials. This manner of credit is fitted to permit private financial transactions, and takes an important place next to the great public transactions, which are chiefly carried out in order to provide food. At present, only the faintest efforts are to be seen in this direction.

If German trade is again to become normal, if it is to be in a position to pay up the debts incurred through the Peace, a great amount of foreign credit will be necessary. In Germany such aspirations are much favoured at present. It is desired to extend the basis of this raw-material credit. It is not desired that such contracts should be undertaken by single firms. It is desired that individual firms in the same line join together and build one coöperative union, which shall take over all responsibility.

The enormous difficulties in industry, the rise in prices of all products, have brought about the circumstance also that just at this time German industry suffers from a want of working capital. This difficulty can to a certain extent be overcome by improvement of the economic organizations in Germany, especially by improvement of our credit organization. But we cannot do without the participation of foreign countries in the future. Such participation by foreign grants of capital is made much easier by the low value of the German mark abroad. German consols can be acquired by foreign countries for small amounts, either in dollar or pounds sterling. The foreign buyer of such consols has always a chance to profit by an improvement of the German valuta, which must sooner or later take place. German industry cannot do without foreign capital for reconstruction.

On the other hand German industry is fighting against loss of her independence with regard to her own production, and this soon would become very probable if foreign capital dominated. To insure herself against the too mighty influence of foreign capitalists, prerogative has been given to German joint stock companies, in such a form that preferred stock has additional voting power. Also special agreements have been made with foreign stockholders, so as to control their right of voting by a committee of German and American trustees. This has already been carried out in the case of an American bank association which took over 25,000,000 in shares of the Electric Works Company.

This brief review concerning the present state of German economics shows a collection of difficulties and troubles, a variety of unsolved problems; but it indicates at the same time the necessary means for overcoming the crisis, and plants the hope that Germany will again be master of her own strength, and will work for the development of her own fortune, as well as for the fortune of the world. But the foundation for an economic renaissance of Germany is not alone regulated work and zealous workmen in Germany itself, but in the same measure the wise support of the other nations. A complete collapse in Germany can only be avoided if the execution of the Peace Treaty is not made a strangulation of Germany, and through America granting credit in years to come.

# Pneumatic Patents

## In the United States

OCTOBER 26.

1,356,508. ROTARY FAN. George B. Allison, Los Angeles, Calif.

1,356,538. PULLING-OVER MACHINE. Ronald F. McFeely, Beverly, Mass.

1. A pulling-over machine having, in combination, a gripper for engaging an upper, means for operating the gripper to impart an initial pull to the upper, and fluid operated means for operating the gripper to impart a supplemental pull to the upper.

1,356,578. HOT-AIR MOTOR. Ira I. Wilson, New Castle, Pa.

1,356,579. SAFETY AIR-VALVE. Daniel Paul Witman, East Somerville, Mass.

1,356,674. BLOWER FOR PORTABLE RIVET HEARTHS OR FORGES. William Walker, Glasgow, Scotland.

1,356,687. METHOD AND APPARATUS FOR MEASURING GAS-PRESSURES. Harold D. Arnold, East Orange, N. J.

1,356,837. AIR-PUMP. Warren E. Ellis, Lebo, Kans.

1,357,140. AIR-FILTER FOR GAS-ENGINES. Frank Bellville and Edwin A. Belleville, Twin Falls, Idaho.

NOVEMBER 2.

1,357,286. PRESSURE-GAGE AND TIRE-VALVE. Hugo Gosstrom, Chicago, Ill.

1,357,312. PNEUMATIC IMPACT-TOOL. William Burlingham, Newport News, Va.

1,357,692. FLUID-PRESSURE BRAKE. Frank H. Dukesmith, Buffalo, N. Y.

1,357,872. ROTARY COMPRESSOR OR EXHAUSTER. John Johnston, London, England.

1,357,877. CONSTANT-LEVEL OIL TANK. Otto Kraus, New York, N. Y.

1. An oil-burning furnace including a combustion chamber; a fuel-reservoir; means for supplying air under pressure to the oil in the fuel-reservoir; a valve-controlled conduit which leads oil from the fuel-reservoir to the combustion-chamber; an overflow-pipe which extends into the oil-reservoir and the inlet-end of which is formed with perforations; a valve which is slidably fitted on the inlet-end of the overflow pipe and is formed with oil-ports that are arranged to register with the perforations in the overflow-pipe when the oil-ports and perforations are sealed by the oil in the fuel-reservoir against the escape of the air under pressure therein; and a float that controls the valve.

NOVEMBER 9.

1,357,946. METHOD FOR THE PRODUCTION OF MASSES OR SOLUTIONS FREE FROM AIR OR OTHER GASES. Benno Borzykowski, Cleveland, Ohio.

1,357,981. COOLING SYSTEM FOR ENGINES. Ned E. Hildreth, Lincoln, Nebr.

1. In a device of the type described, the combination with a water jacketed internal combustion engine mounted upon a hollow base, of a radiator removably mounted within said base and connected with the water jacket of said engine, and means for forcing a current of air through said radiator operated by said engine.

1,358,034. LOOSE-FIBER CLEANER. Jacob A. Snyder, Cincinnati, Ohio.

1,358,086. METHOD OF AND APPARATUS FOR MEASURING SUPERFICIAL AREAS. Charles E. Lucke, New York, N. Y.

1. The method of measuring surface areas, which consists in placing an object with its surface to be measured against a fluid permeable measuring surface of a definite size and of uniform permeability per unit of area, and determining the area of the surface to be measured from change in the conditions of flow of a fluid through the measuring surface under a difference in pressure on opposite sides of said surface due to the presence against the measuring surface of the surface to be measured.

1,358,118. VACUUM GASOLENE FEED-TANK. James Shephard, Detroit, Mich.

1,358,166. FLUID-PRESSURE-CONTROLLING APPARATUS. Lincoln A. Lang, Chicago, Ill.

1,358,238. COMPRESSED-AIR AUTOMATIC OIL AND WATER PUMP. Albert Otto and William Otto, Kansas City, Mo.

1,358,259. WAVE-POWER AIR-COMPRESSOR. Samuel P. Stein, Newark, N. J.

1,358,313. MACHINE FOR DRYING FOOD-STUFFS. Numa C. Hero, New Orleans, La.

1,358,333. FILTER, CLEANER, OR WASHER FOR AIR. Joe Rudloff, Gallup, N. Mex.

1,358,443. OZONE-GENERATOR. Siegfried Held, Chicago, Ill.

1,358,524. MEANS FOR AUTOMATICALLY INFLATING PNEUMATIC TIRES. Jowel Cecil Cooper, Hempstead, Tex.

1,358,637. BLOWPIPE APPARATUS. William Leo Herron, Brooklyn, N. Y.

1,358,669. AIR-MOTOR. Antonio Alberico, Joliet, Ill.

NOVEMBER 16.

1,358,764. PNEUMATIC SLEEPER FOR RAILROADS. Hilding Lubeck, Herserud, Sweden.

1,358,778. METHOD OF LOCATING LEAKS IN UNDERGROUND PIPES. George V. Payne, Chicago, Ill.

1,358,798. AUTOMATIC SAFETY DEVICE FOR AIR-COMPRESSORS. John Tiffin, Detroit, Mich.

1,358,987. MILKING-MACHINE. John Prince, Malanda, Queensland, Australia.

1,359,085. APPARATUS FOR TREATING WASTE ORGANIC SUBSTANCES. Angus Maclachlan, Perth Amboy, N. J.

1,359,119. PERCUSSIVE TOOL. William A. Smith, Easton, Pa.

1,359,122. TRAIN-STOP. Henry Bush Spencer, Thomas Short, and Napoleon Derocher, Ottawa, Ontario, Canada.

1,359,144. AIR - CONTROLLED - PISTON DOOR-CHECK. Fred P. Angell, Battle Creek, Mich.

1,359,155. OXYACETYLENE, CARBOHYDROGEN, OR THE LIKE TORCH. Frank F. Davis, Chester, Pa.

## In Great Britain

151,295. PNEUMATIC PERCUSSIVE TOOLS. Sir. W. G. Armstrong. Whitworth & Co. Ltd., R. W. Wilson, and F. A. Campbell, of Newcastle.

151,512. SUPPORT FOR RIVETING HAMMERS. J. K. Smith of Stockton-on-Tees.

151,528. ROCK DRILL. S. Fisher, of Johannesburg.

149,037. BRAKING APPARATUS. The Westinghouse Brake Co. Ltd., and L. G. Stone, both of London.

149,020. SEPARATING AND PURIFYING WHEAT AND OTHER CEREALS. J. Higginbottom, of Liverpool.

139,786. PNEUMATIC HAMMERS. The Liberty Tool Company of Baltimore, U. S. A.

150,363. COMPRESSOR. F. G. J. Butler, of London.

150,677. PERCUSSIVE TOOL. International Convention, August 21st, 1919. Chicago Pneumatic Tool Co. of New York.

150,687. PNEUMATIC DRILL. International Convention, September 4th, 1919. F. Krupp Aktiengesellschaft.

149,803. VALVE. E. A. Mitchell of London.

151,192. RECOVERY OF COMBUSTIBLE MATERIAL. A. Andre of Chenee, Belgium.

151,493. BREAKING APPARATUS. Westinghouse Brake Co. Ltd., a communication from The Westinghouse Air Brake Company of Pittsburg.

## In Germany

5b, 8. H. 78630. August Horschmann, Werne (Westphalia). Stop and feeding device for pick hammers. 10th 15. 19.

46d. 750888. R. Frister & Richard Bohmer, Berlin-Oberschoneweide. Valve motion for compressed air motors and drills.

5b, (14). 325633, of the 7th August, 1919. Kaspar Auer, Hohr. Feeding regulation for rock drills with turning device. The feeding end of the spindle resting on balls in the feed nut, is regulated by an outside brake adjusted by hand during operation.

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